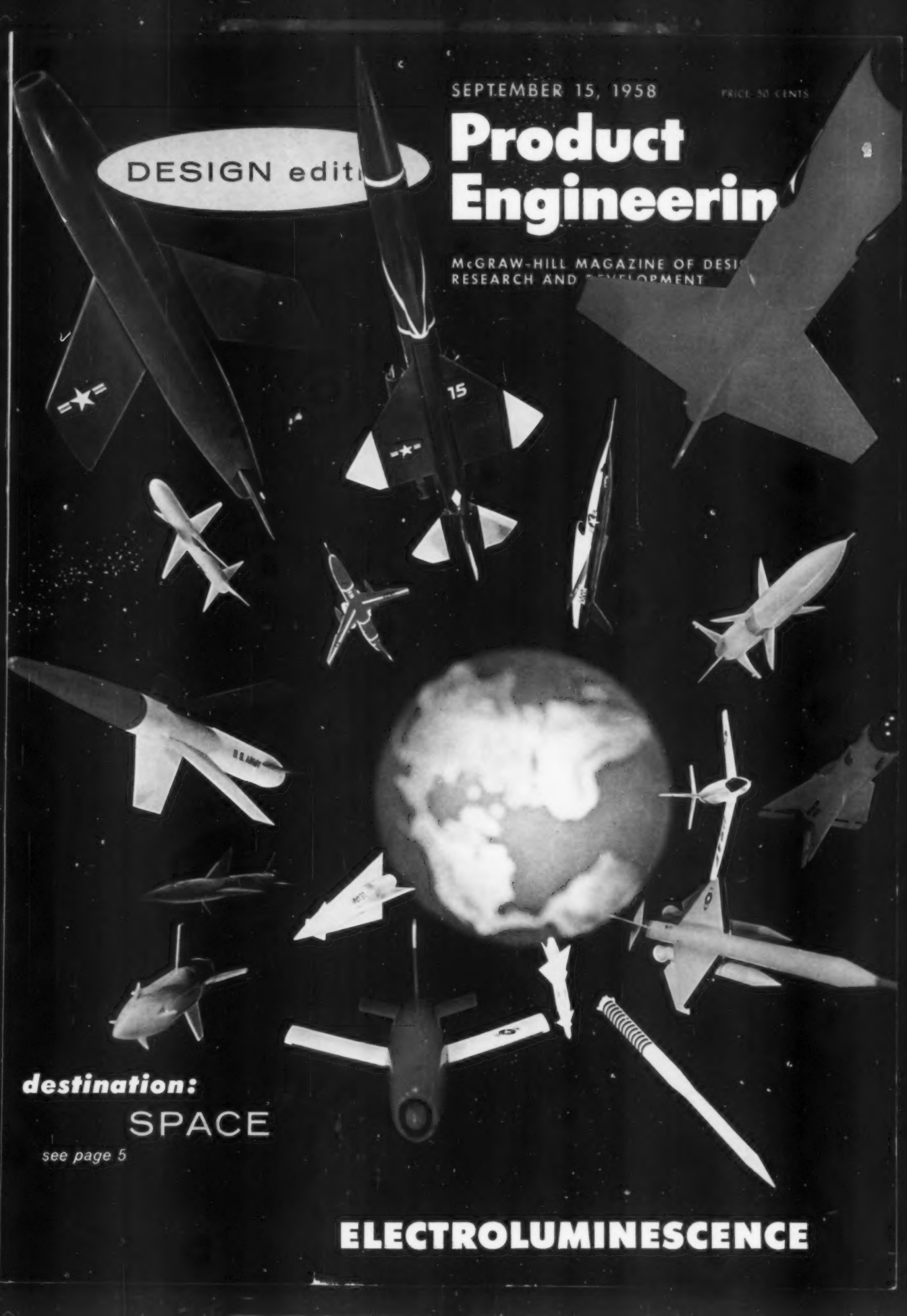
SEPTEMBER 15, 1958
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SPACE
see page 5
ELECTROLUMINESCENCE

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SHAFT-TYPE OIL SEALS More than 20 types, forming thousands of size combinations for shafts from ¼" to 50" O.D., are available — the majority from stock. These seals are used for the vast majority of shaft sealing problems from simplest dust exclusion to high-speed, high-temperature fluid retention and foreign matter exclusion under rugged operation where high sealing efficiency must be maintained over long service life.

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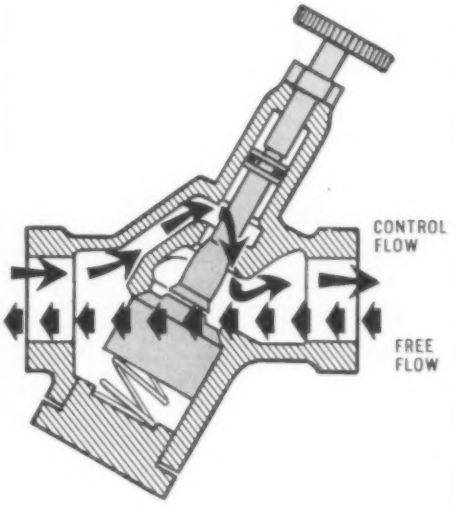
Tranquilize your cylinders

Rx

Ross speed control valves



FREE FLOW TO CYLINDER (LEFT)
CONTROLLED FLOW FROM CYLINDER

PRICED WITH THE LOWEST

By keeping full power driving the cylinder but metering the flow from it, you can get smooth, positive and infinitely variable control of the cylinder speed without the problems that come with trying to adjust cylinder movement by varying inlet pressure. This is why speed control valves are so satisfactory for making cylinders act right. And why do so many specify Ross speed controls?

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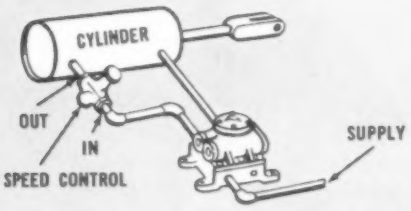
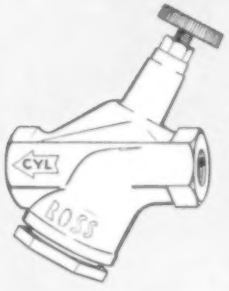


The speed control valve as used between a 4 way valve and a cylinder, shown above, regulates (slows down) the piston rod retraction.

FULL RANGE IN STOCK



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Jungle missionary straightens out shaft problem

Hazardous passage. Drifting debris, submerged rocks and ever-shifting shoals pose constant threats to this missionary. He is Brother Dismas of the Maryknoll Fathers, whose frequent missions take him up and down uncharted, unpredictable waters deep in the jungles of Bolivia.

There's no telling what he may run into here. One of the menaces is the dead *Tajibu* or "vegetable iron" tree.

A giant hardwood, the *Tajibu* dies and topples into the river. The wood is so heavy the whole tree sinks. And so *hard* it's been used in place of bearing metal. Imagine what happens when a *Tajibu*, cartwheeling along in the swiftly running current, tangles with the boat's slender drive shaft . . ! It's virtually impossible to detect one fast enough to avoid being rammed.

Man-eating Piranhas and alligators lurk in these jungle rivers, but Brother Dismas dives in and removes bronze propeller shaft, bent in collision with an unseen *Tajibu*. With nearest help several days' journey away, he has no alternative but to attempt an on-the-spot repair.

Riverside "shop"—The bent bronze shaft is first heated over an open fire, then placed on a log and hammered straight. This primitive repair job has to get him back to his base. "After a few experiences like this, I got a bright idea," says Brother Dismas. "I decided to try one of your Monel shafts.

"Monel shaft arrives . . . and was I glad to see it. I've found that bronze shafts bend too easily in these rivers and steel shafts corrode and chew up bearings. We picked up our new Monel shaft in an ox cart at the airport and were underway with it in record time. Now we have . . .

"A sturdy shaft — at last!" Monel* nickel-copper alloy or another Inco Nickel Alloy may carry you, too, safely through the hazardous waters of metal selection. Let our booklet *Standard Alloys for Special Problems* point the channel. The International Nickel Company, Inc., 67 Wall Street, New York 5, N. Y.

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Product Engineering

THE McGRAW-HILL MAGAZINE OF DESIGN, RESEARCH AND DEVELOPMENT

SEPTEMBER 15, 1958 Vol. 29, No. 38

✳ **Electroluminescence—The New Light** 74... Annesta R. Gardner, Associate Editor
This radically different kind of illumination needs no white-hot filaments, or arcing, or activating rays. It's available in panels that can be formed to shape, that require only a trace of current and will last 30,000 hours or more.

Conveyor Rolls for Moving Metal Strip 78... L. H. Austin, United Engineering and Foundry Co
How the rolls are grouped determines their grip on the metal for drive or drag. Author describes force involved, and also supplies working examples.

STAFF REPORT

Take Your Pick of Immersed Motors 80... Franklin D. Yeaple Jr, Associate Editor
An underwater motor can be canned, potted or given sealed-in fluid—and now we have some of completely open construction.

✳ **Magnetic Welding for Vinyl-clad Steel** 82... Ford R. Park, Associate Editor
The force-welding method has been adapted to work with this tricky material. Article gives first data on weld strengths, welding arrangements, ways to escape design trouble.

Additives Strengthen Sintered Nylon 86... L. W. Alexander, Halex Corp
Powder techniques can now turn out mechanical parts that are stronger—and without sacrificing wear resistance.

Design Features in New Products 88... Seats load air passengers into surprise package; this setup banishes kinks, then machines stock; new twist to twisting trick.

Debugging—That Last Step in Design 92... D. C. Cumming, Westinghouse Electric Corp
Performance of a new machine rarely meets expectations—before it can go to customers, you must clean out the bugs. Best way is with this precise, step-by-step approach.

DESIGN FILE

13 Handy Lever Mechanisms 98... Federico Strasser, Mankowitz & Strasser, Ltd
Lever and linkage examples show versatility of these devices.

Edge Area of Bent-up Shapes 101... S. Warren-Kaye, Flight Refuelling, Inc
This k-factor will speed up the answers.

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Interesting to Note . . .

1. Chance-Vought Regulus I
2. Boeing Bomarc
3. Bell Rascal
4. Douglas Sparrow II
5. Northrop Snark
6. Chance-Vought Regulus II
7. Convair Terrier
8. Martin La Crosse
9. Bell X-2
10. Hughes Falcon
11. Douglas Sparrow I
12. Douglas Nike Hercules
13. Douglas Nike Ajax
14. Lockheed X-7
15. Martin Bullpup
16. Ryan Firebee
17. Martin Vanguard

Destination—Moon

With the Air Force's first attempt to send a missile to the moon ending in failure, and the second try approaching the countdown stage, let's see how long man has been thinking about a lunar voyage. As far back as 120 AD, Plutarch wrote of the moon's being a solid, smaller than the earth and inhabited by demons. Another imagineer, Lukian, wrote a book, *True History*, in which a ship is sucked up by a whirlwind and finally comes to rest on "a great countrie in the aire, like a shining island." Such fictional day-dreamers were abruptly halted in 1145 by church decree banning talk of moon travel as heresy.

In the mid-17th Century the famous French soldier and dualist Cyrano de Bergerac wrote two novels about flights to the moon. His methods of locomotion showed great imagination. Space travelers sat in large bottles of dew and, in the morning as the dew vanished, so did the bottles. Another method involved an iron vehicle propelled by throwing lodestones in front of it. A third method used a box with an array of rockets attached to it. Unwittingly, Cyrano became the first to find the answer—propulsion by reaction.

For centuries man talked about life on the moon. The great mathematician Karl Gauss suggested building a huge triangle on earth in hopes than moon-men would understand a common mathematical symbol and somehow reply. In Paris a prize of $20,000 was set aside for the first man to successfully communicate with another planet—Mars was ruled out as being too easy. Space talk increased. In 1865 Jules Verne wrote his *De la Terre a la Lune*, while in the same year Archile Eyrand became the first to describe a spaceship in detail.

Our cover photo shows some of the current space vehicles. Only

(Continued on page 7)

Product Engineering
A McGRAW-HILL PUBLICATION

SEPTEMBER 15, 1958 Vol. 29, No. 38

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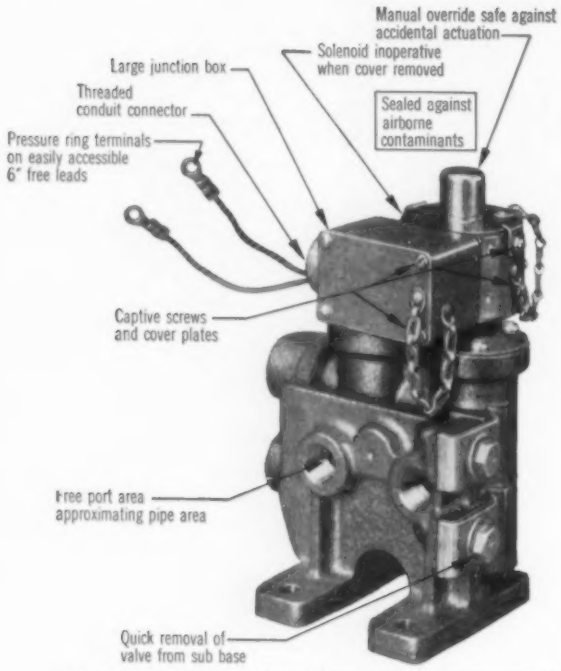
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With all its superior operating features the Crescent valve is probably the most competitively priced line on the market, particularly in the light of liberal trade and quantity discounts.

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Space, labor and materials savings have been pointed out to us by many equipment manufacturers as benefits from Crescent's compact design.

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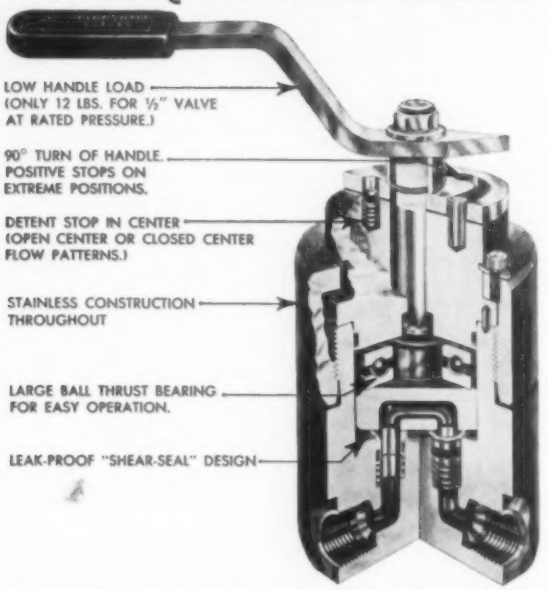
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Long, maintenance-free service is assured because the optically flat metal to metal sealing surfaces of the sealing rings and mating rotor faces are protected by staying in constant intimate contact; flow is always through the center of the "Shear-Seal", never across sealing surfaces (as in conventional valve design). Sealing qualities actually improve as the self aligning "Shear-Seals" lap themselves to a more perfect fit with each valve operation.

Of course, there is no external shaft leakage, because the pressure is confined to the flow passages.

Write for Catalog 58-59

CONTROL VALVE DIVISION **Barksdale valves**

5125 ALCOA AVENUE • LOS ANGELES 58 • CALIFORNIA

the Bell X-2 is designed for man to ride. The Snark, Regulus I and Firebee (drone) have air-breathing engines while the rest are true rockets. Topping Models Inc. Akron, Ohio, supplied most of the models.

For photo fans: Sid Karsen, McGraw-Hill Photographic Dept, achieved the effect by shooting a triple exposure. First he took a picture of the earth painted on a glass plate surrounded by small models; then he draped a black cloth over the set and shot more models on a second glass tier; finally he photographed a third glass plate holding the rest of the models.

Forgotten Pioneer

Because early man had little need for illumination after dark, for centuries he was content with torches and oil lamps. After all why did he need elaborate lights past sunset? Night air was a health hazard and if the work couldn't be done during daylight hours, let it wait until next day. Fortunately, not all people were satisfied with fire as the sole source of light. As early as 300 BC, Servius Tullius, sixth king of Rome, wrote of the emission of sparks from combed hair. Yet this phenomenon, like the glow from a ship's mast or the sparks from a javelin when it hit a rock, was simply considered a message from the gods.

During the early 1700s, the Royal Society in London elected as a Fellow a little-known instrument maker named Francis Hanksbee. So minor a figure was he that his birth and death dates have never been recorded in the vital-statistics pages of science. His name is perpetuated only through his one publication, *Physico-Mechanical Experiments on Various Subjects* (1709). However, in this book he describes an experiment which preserves his name in the history of illumination: One end of a glass tube is inserted in a vacuum jar, the other end in a dish of mercury. When a valve is opened, air pressure forces mercury through the tube and sprays it against sides of the jar. The resulting glow was "like flashes of lightning."

This eerie luminescence could be seen at a distance of three or four feet and grew more intense with better vacuum. For the first time, an unknown scientist had brought the problem of artificial lighting into the laboratory. Today with the electric bulb, fluorescent light and now electroluminescence (p 74), the experiments of Francis Hanksbee have been all but forgotten.

Mysterious F.U.O.

Getting the bugs out of machinery (p 92) is a common problem every designer faces sooner or later. Debugging an army is another battle many generals have faced; and some have lost. During World War II, more than 1½ million American soldiers were put out of action, many permanently, by insect-transmitted diseases. Deaths in some areas exceeded those from wounds and accidents. Greatest offender of the insect-borne maladies was dysentery. Easily second was the even more disabling malaria.

According to Col. Emory C. Cushing, USA Ret., in a publication recently issued by the Smithsonian Institution, malaria outbreaks were the major reason for German abandonment of both Corsica and Sardinia with hardly a shot fired. In the New Guinea campaign there were but a few soldiers, among thousands who went into the jungle, who did not come down with some kind of fever at least once.

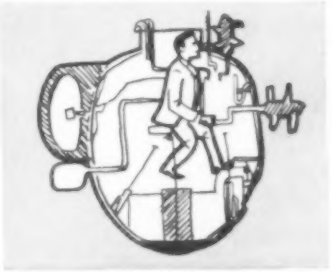
In the battle for Sicily, several thousand men were put out of action by the tiny sand fly (*Phlebotomus*). Within a week after the initial landing, hundreds of men filled field hospitals with malaria-like diseases. Because the medics had never before encountered papatacci fever, their hospital records simply stated "f.u.o." (fever of unknown origin).

By war's end, effective insect killers like DDT were developed, but unfortunately many Americans still carry the malaria and dysentery they incurred over a dozen years ago.

The Turtle and the Eagle

Military personnel are now coming to the realization that underwater craft may be as great a defense as missiles and aircraft. Two atomic submarines that recently made a historical voyage under the polar ice cap should teach us that the same potential we have is also possessed by the Soviet. At last count, we had about 115 subs as opposed by the Soviet's 500-plus.

America's first underwater craft dates back to 1772 when a Yale student, David Bushnell, constructed a weird saucer-shaped craft he called the Turtle. This contraption was just large enough to accommodate one man in a sitting position and was driven by a screw propeller turned by hand from an interior crank. Its armament consisted of a torpedo tied to the bow and so arranged that it could be attached to the hull of an enemy vessel. In 1775, Bushnell was asked to take his submarine into New York harbor and sink the British flagship Eagle.



Bushnell was content to be a designer and wanted no part of any nocturnal underwater adventures so a corporal from General Putnam's Army, Ezra Lee, made the attack. Everything went fine until the submerged Turtle navigated under the Eagle's stern. Copper sheathing on the flagship's hull and a slight current caused Lee trouble. He quickly became frightened, cut the torpedo adrift and headed for shore. The torpedo went off on schedule a few feet from the Eagle, causing that ship's crew to scramble for cover.

For designers who also may have underwater troubles, the article on page 80 describes several new developments in electric motors designed to run in water.

—Benedict A. Leerburger Jr.

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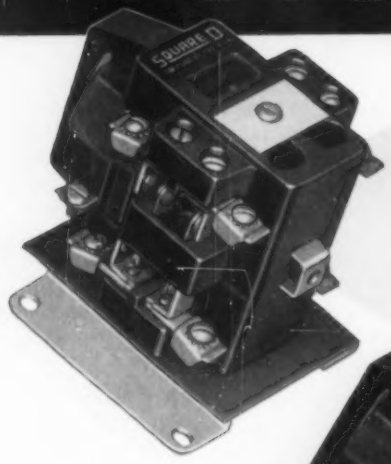

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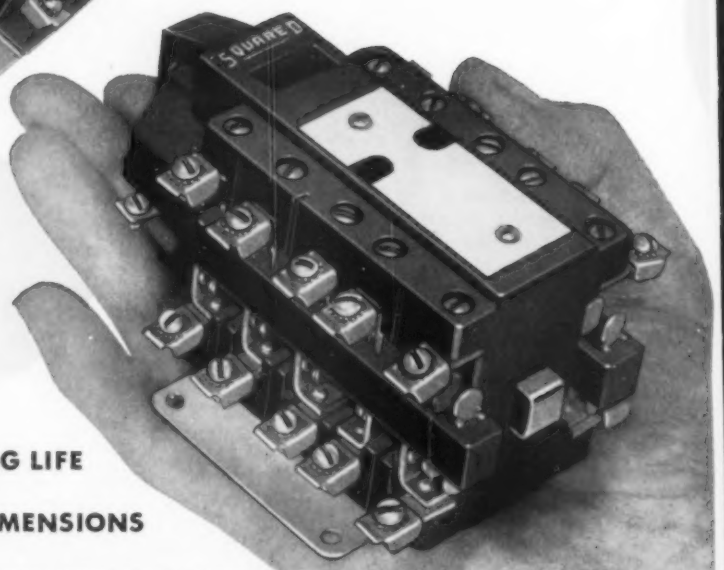

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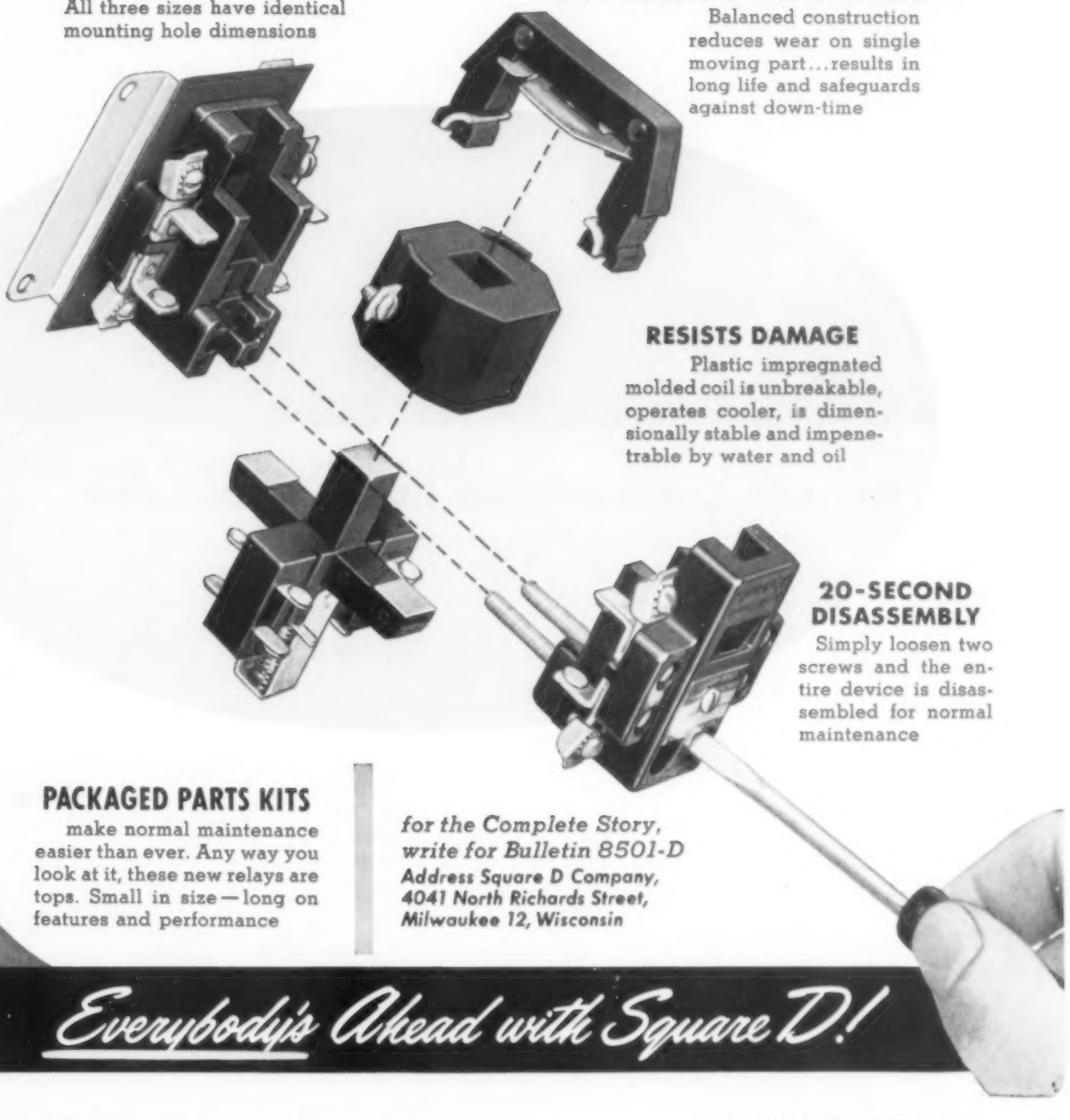
Take Them Apart in 20 seconds...from the Front!
Not One Bit of Tear-Down Space Needed!

MOUNTING SIMPLIFIED
All three sizes have identical mounting hole dimensions

OUTSTANDING PERFORMANCE
Balanced construction reduces wear on single moving part...results in long life and safeguards against down-time



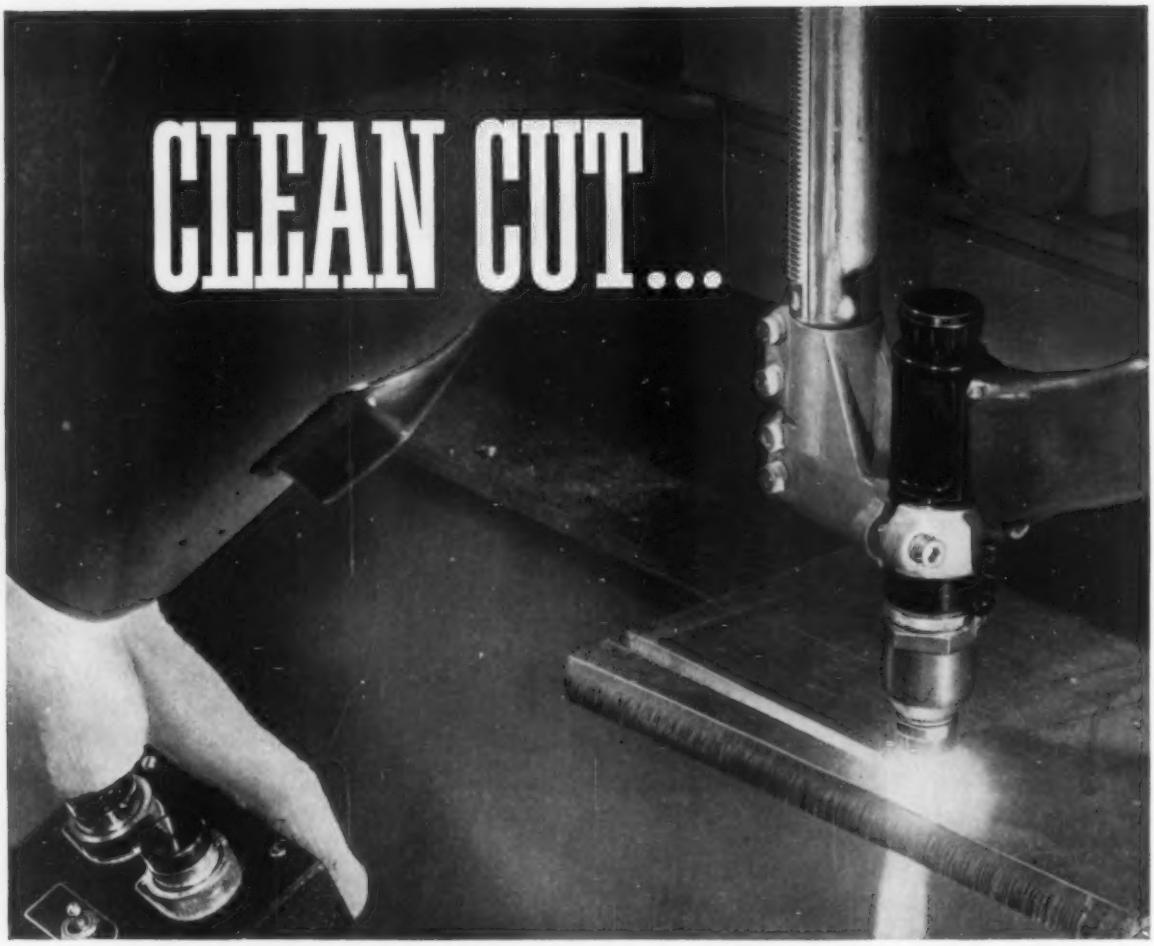
RESISTS DAMAGE
Plastic impregnated molded coil is unbreakable, operates cooler, is dimensionally stable and impenetrable by water and oil

20-SECOND DISASSEMBLY
Simply loosen two screws and the entire device is disassembled for normal maintenance

PACKAGED PARTS KITS
make normal maintenance easier than ever. Any way you look at it, these new relays are tops. Small in size—long on features and performance

for the Complete Story, write for Bulletin 8501-D
Address Square D Company, 4041 North Richards Street, Milwaukee 12, Wisconsin

Everybody's Ahead with Square D!



. . . HELIARC Cutting turns hours to minutes

Before: It took 1½ hours to chip an 18-inch hole in an aluminum dome ⅝-inch thick. NOW—The hole is cut in *one minute*—with HELIARC Cutting.

Before: A 54-inch diameter dome hole in ⅝-inch rolled aluminum plate required about 5 hours, with chipping hammers. NOW—Manual HELIARC Cutting does it in about 4½ *minutes.*

HELIARC Cutting employs an extremely high-temperature, high-velocity arc that gives cutting speeds up to 1000 inches per minute on ¼-inch-thick material. It makes saw-like cuts, either square or beveled, in materials up to 3 inches thick . . . *and*, you can take the torch to the work. HELIARC Cutting is equally effective on aluminum, stainless steel, magnesium, copper, carbon steel, or cast iron.

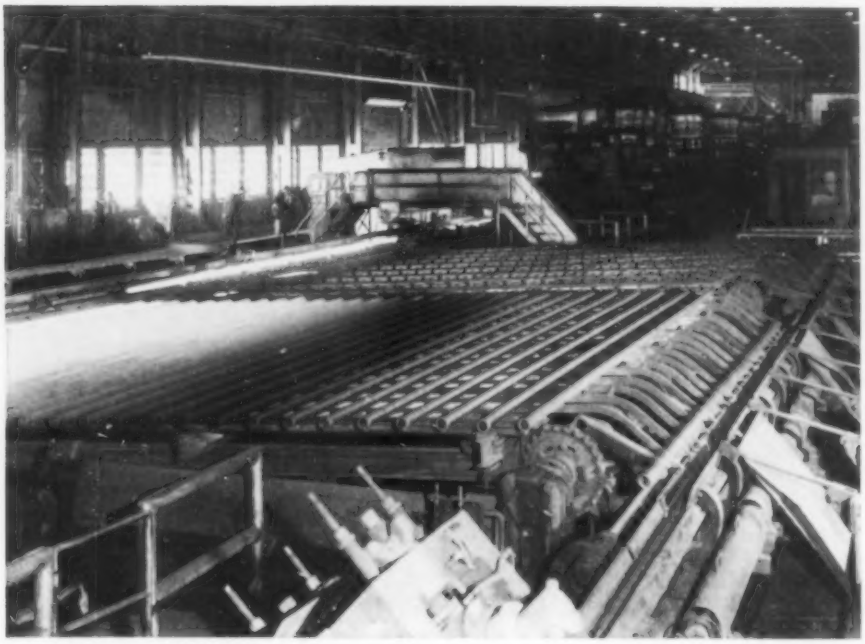
See for yourself—ask your nearest LINDE representative to *prove* that HELIARC Cutting slashes time and labor costs over conventional methods. Call your local LINDE office today! Or write Dept.P-93,LINDE COMPANY, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N.Y. Offices in other principal cities. In Canada: Linde Company, Division of Union Carbide Canada Limited.

Linde TRADE-MARK

UNION CARBIDE

"Linde", "Heliarc", and "Union Carbide" are registered trade-marks of Union Carbide Corporation.

Many industrial operations need the extra qualities of Promal chain



LINK-BELT H CLASS PINTLE CHAIN with pusher attachments on this pipe cooling rack designed by Aetna-Standard Engineering Co. receives white-hot pipe from finishing operations in a continuous butt weld mill. Controlled chain speed permits uniform cooling of outer tube periphery.

Specially heat-treated malleable iron resists heavy and abrasive loads

Fewer conveyor shutdowns and minimized replacements are economies realized by users of Link-Belt Promal chain. Promal will withstand repeated cyclic heating up to 1000° F. Its greater strength absorbs continuous impact loads, and high wear resistance supplies the durability to cope with severe abrasion.

A Link-Belt Development

Promal is more than a partially annealed or surface-hardened malleable iron. Developed by Link-Belt, this specially heat-treated malleable iron is actually transformed into a metal of radically different physical properties. Promal, because of uniform microstructure throughout its whole section, provides greater ultimate strength, higher yield point, exceptional fatigue resistance.

Where and how to apply Promal

Choose Link-Belt Promal chains for highly abrasive or heat-conditions—for extra strength and wear resistance demanded by heavy loads or long sliding conveyors. They last much longer . . . cost but a little more.

The wide range of Link-Belt chains available in Promal includes all types of cast and combination chains.

SMGL-618 PROMAL chain conveyor is another example of the applicability of heat-resistant Promal. This chain conveyor with special joint design and riser attachments picks up and conveys sheet steel through furnace. Chain has operated continuously for two years without failure. The heat-resistant properties of Promal also make it a desirable material for use on low-temperature heat-treating equipment.

PHYSICAL PROPERTIES OF PROMAL

Compare this with other ferrous materials used for chain applications.

Yield Point	55,000 pounds per sq. in.
Ultimate Strength	75,000 pounds per sq. in.
Fatigue Strength	35,000 pounds per sq. in.
Elongation	10 to 14% in 2 inches
Average Brinell Hardness	170 to 190

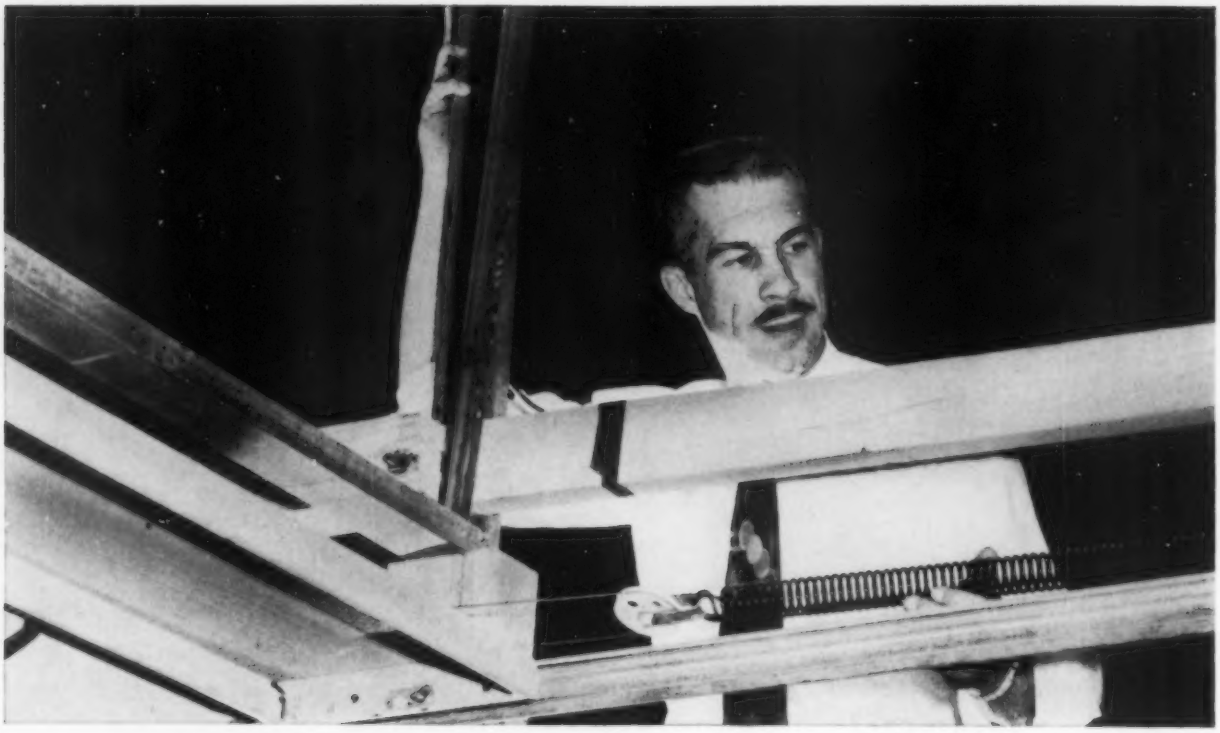
PROMAL'S high strength factors make it ideal for especially long elevators and conveyors.

HEADQUARTERS for chains, sprockets and other Link-Belt products is your nearby Link-Belt office. Refer to the yellow pages of your local phone directory.

LINK-BELT

CHAINS AND SPROCKETS

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office: New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 14.523-B

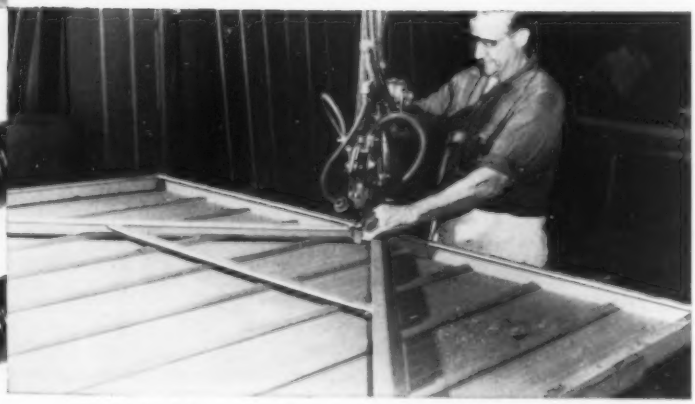


At Steel Door . . .

USS American Springs

thanks to AS&W

In the American Steel & Wire Fatigue Laboratory, a technician runs tests on a USS American Spring, designed for Steel Door use. On the basis of this test a change in hook design was recommended to give longer spring life.



A Steel Door workman assembles a Berry One-Piece Door. This company uses steel exclusively for all doors because of its many consumer advantages. Steel is stable, won't warp or swell. Steel doors need less maintenance and preparation, and steel doors are easy to operate.

This close-up shows the improved hook on the extension springs supplied by American Steel & Wire for the Steel Door overhead garage doors.

Highly-lapped metal-to-metal surfaces of this

stretched 31,000 times and still going strong...

Spring Engineering Research Service

The Steel Door Corporation, Birmingham, Michigan, is the world's largest manufacturer of residential garage doors. For the production of these doors they use about 150,000 USS American Springs every year. Steel Door asked American Steel & Wire for a statistical evaluation of the fatigue life of the extension hook-type springs they use. The AS&W Spring Engineering Research Service tested these springs in the Fatigue Laboratory and recommended a change in hook design.

So successful was this design change that the life of the springs has been materially increased. At the Steel Door plant a cycle test was set up using USS American Springs on an overhead door. At the present time these springs have completed over 31,000 cycles without showing any sign of failure. This is the equivalent of 25 years of normal usage.

Mr. Ralph Qualman, Advertising Director and Service Manager, says: "It is extremely important that the springs—especially those used on sectional doors where the strain is greatest—have proper tension and a long life. American Steel & Wire supplies Steel Door with springs that meet their engineering specification and life expectancy."

If you have a spring problem or would like advice on the use of springs in your product, get in touch with our general offices in Cleveland, or any American Steel & Wire Sales Office. You can benefit from the knowledge of AS&W's Spring Engineering Research Service. The Service has been engaged in laboratory experiments of static and dynamic testing for 20 years and has accumulated invaluable data on stress and fatigue life of steel springs, while endeavoring to improve efficiency in the use of steel—from steel chemistry through product application—to more economically cope with today's rigorous demands. This accumulated knowledge of the AS&W Spring Engineering Research Service is at your disposal. *American Steel & Wire, General Offices: Rockefeller Building, Cleveland 13, Ohio.*

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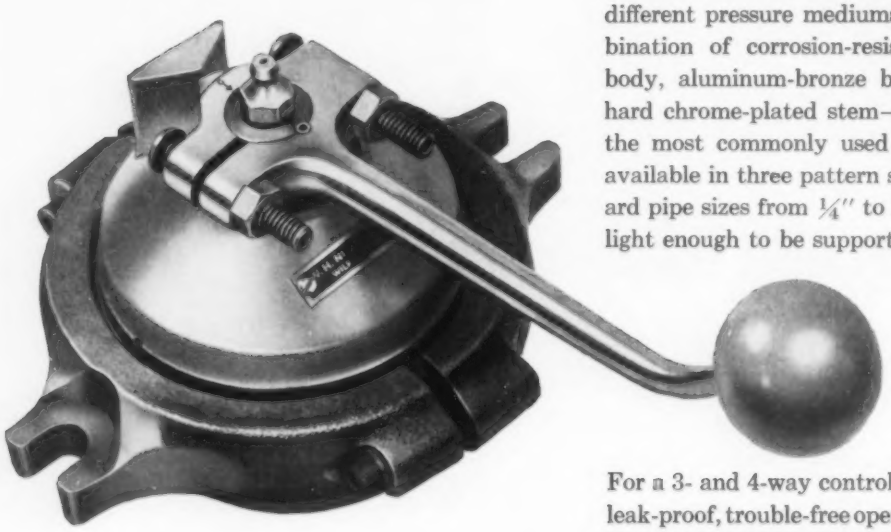
American Steel & Wire Division of USS **United States Steel**

Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors • Tennessee Coal & Iron Division, Fairfield, Ala., Southern Distributors • United States Steel Export Company, Distributors Abroad

Here's a control valve that assures you

leak-proof service



Highly-lapped metal-to-metal surfaces of this Nicholson control valve assure you leak-proof service. The O-ring stem packing and O-ring seal between the body and base make joints leak-proof without excessive bolt tension.

You can use the Model 300 with air, water, hydraulic fluid or oil as the pressure medium . . . at operating pressures to 300 psi. Use it to activate single- or double-acting cylinders. Simple and rugged, this valve provides accurate, repeatable control of equipment such as presses, hoists, clutches and chucks. Valve maintenance is no problem . . . all stem, base and disc bearing surfaces are lubricated through one easily accessible fitting on top of valve stem. Lubricant reservoir in base reduces frequency of lubrication.

No need to stock valves or parts for service with different pressure mediums. This valve's *one* combination of corrosion-resistant materials—bronze body, aluminum-bronze base, stainless-steel disc, hard chrome-plated stem—is well suited for all of the most commonly used pressure mediums. It's available in three pattern sizes covering five standard pipe sizes from ¼″ to 1″ . . . small enough and light enough to be supported by connected piping.

For a 3- and 4-way control valve that will give you leak-proof, trouble-free operation, specify Nicholson. W. H. Nicholson and Company, 14 Oregon St., Wilkes-Barre, Pa. Sales and Engineering Offices in 98 principal cities.

Write for Bulletin 300 . . . covering design, construction, sizes and applications for the Model 300

NICHOLSON

OF WILKES-BARRE

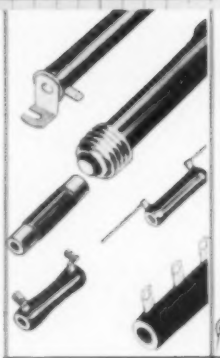
TRY A FRESH APPROACH

OHMITE® industry's most complete line of WIRE-WOUND RESISTORS

WRITE ON COMPANY LETTERHEAD FOR CATALOG 58

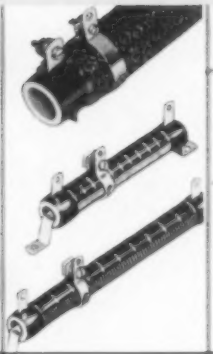
Ohmite has exactly the resistor you need

Ohmite offers the most complete line of high quality resistors on the market . . . fixed, adjustable, tapped, noninductive, and precision resistors in many sizes and types of terminals . . . in a wide range of wattages and resistances. All-welded construction. Ohmite application engineers will be pleased to help you in selecting the resistors for your job.



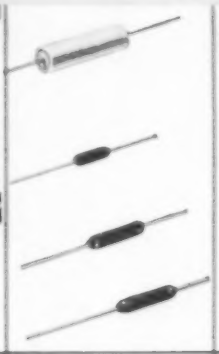
FIXED

Resistance wire is wound on a ceramic tube and protected by a vitreous-enamel coating. Many kinds of terminals available. May be single winding, tapped, or multisection. Watts, 3 to 1000; ohms, 0.1 to 1,700,000.



DIVIDOHM ADJUSTABLE

Vitreous-enameled resistors with the wire exposed in a strip along one side for contact with adjustable lugs. Most Ohmite resistors can be ordered adjustable. Watts, 10 to 1000; ohms, 1 to 100K.

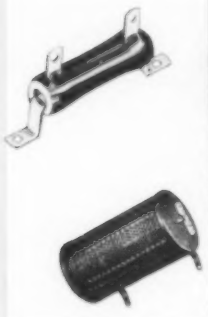


AXIAL LEAD

Small vitreous-enameled resistors with wire leads axially welded to caps on ends of the units. Also TUBEOHM ceramic jacketed style. Watts, vitreous 3 to 10; Tubeohm, 5 to 25; ohms, vitreous 1 to 50K; Tubeohm 1 to 25K.

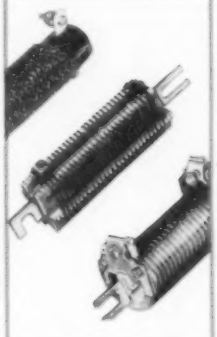
THIN

Resistance wire is wound on a core of flattened oval cross section and protected by vitreous enamel. Several sizes. Fixed, adjustable or tapped. Watts, 10 to 75; ohms, 0.1 to 100K.



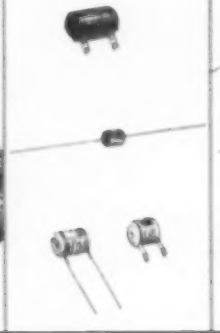
NONINDUCTIVE

Tubular vitreous-enameled resistors with special winding. Dummy antennas consist of assemblies of several resistors. Watts, 5 to 1000; ohms, 1 to 5000.



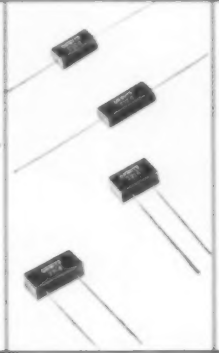
HIGH CURRENT

CORRIBS have exposed corrugated ribbon wound and enameled on a tubular core. POWR-RIBS have bare coil of edgewise wound ribbon or round wire.



PRECISION WIRE-WOUND

Pie-wound resistors, encapsulated, impregnated, or hermetically sealed in glass. Also standard resistors wound to close tolerance. Watts, ⅛ to 2; ohms, 0.1 to 5 megohms.



PRECISION METAL FILM

Consists of a unique metal film permanently bonded to a glass plate. The assembly is sealed in a high-temperature resistant plastic case. Watts, ¼ at 150°C to ½ at 105°C; ohms, 25 to 350K.

SPECIAL VARIETIES

Ohmite can provide toroids, flat strips, plaques, special-sized tubes, or tubes with mixed terminals, etc. Watt ratings and resistances are available as required.

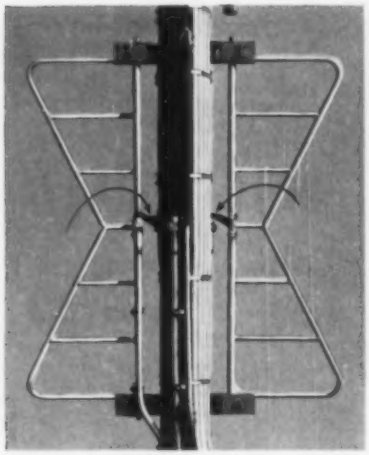
RHEOSTATS RESISTORS RELAYS
TAP SWITCHES TANTALUM CAPACITORS
R. F. CHOKES VARIABLE TRANSFORMERS

OHMITE MANUFACTURING COMPANY
3611 Howard Street, Skokie, Illinois

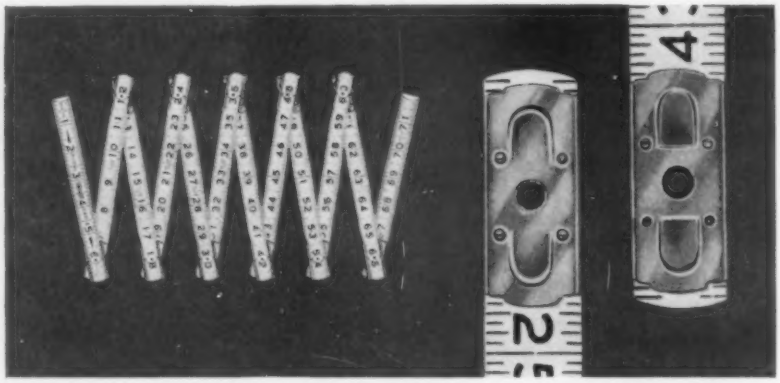
OHMITE® QUALITY Components

TRY A FRESH APPROACH

Don't just take your metals for granted—specify the properties you need. The Man from Anaconda may come up with some very interesting answers.



Up where TV broadcast antennas stand, normal wind causes flexing of metals. So jumpers between coaxial cables and radiators must be resilient – beside being conductors, giving some structural support. Ordinary phosphor bronze seemed adequate, but there were fatigue failures.

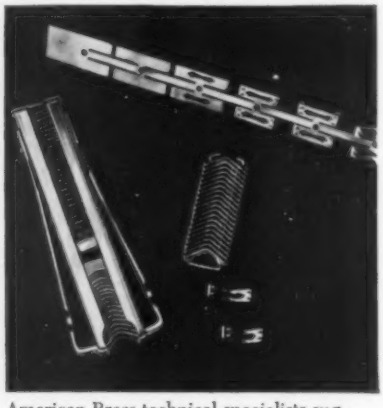


To stimulate sales of its top-quality folding rule, and to meet Navy specifications, Eagle Rule Mfg. Corporation sought a metal for rule joints that would resist wear and corrosion, and provide the proper spring tension. Phosphor bronze, which had these qualities in excess of needs, cost too much.

American Brass suggested three alloys. Eagle Rule chose Ambronze-420 (88 Cu, 11 Zn, 1 Sn) because rule joints of this alloy met all requirements, withstood 400,000 cycles in wear test (Navy required 7000). It cost only pennies per pound more than yellow brass, much less than phosphor bronze.

RCA listed desirable properties of phosphor bronze – added *extra*-high endurance, *extra*-long fatigue life. American Brass suggested Duraflex®, Anaconda superfine-grain phosphor bronze. RCA tried it, found it the answer–at no extra cost–specified Duraflex to the manufacturer, Dielectric Products Engineering Co., Inc., Raymond, Maine.

Technical Oil Tool Corp. asked Anaconda to help select the metal for a new magazine-type clip used to close surgical incisions. The metal had to provide the right tension to hold edges together, yet open easily–form readily, hold sharp die-cut edges, be proved in surgical use.



American Brass technical specialists suggested Nickel Silver, 18%-719 as best suited to meet all requirements. Autoclip, shown in use above, is the result. Incisions are held together with least damage to tissues. Surgeons can work faster in applying and removing clips.

STARTING with 93 standard alloys, The American Brass Company can make minor variations in composition, fabrication, and annealing to provide an almost unlimited number of combinations of useful properties. When new or unusual problems arise, ask for the help of the Technical Dept. in selecting the right metal. For such help or a copy of Publication B-32, "Anaconda Copper & Copper Alloys," write: The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario, Canada. 5850

ANACONDA®

COPPER • BRASS • BRONZE • NICKEL SILVER
MILL PRODUCTS
Made by The American Brass Company

open motors for extreme conditions

Save up to 60%!

Here's an amazing advance in motor technology! It's the *Super-Seal* motor line — an open motor design so completely unaffected by moisture, dust, dirt, oil, acids and alkalis that it can be used in many applications previously requiring more costly enclosed motors. *Savings range from 15 to 60%.*

Super-Seal motor superiority results from revolutionary insulating techniques. Available in any integral horsepower size, smaller *Super-Seal* motors incorporate an encapsulated stator. A durable epoxy resin encloses the stator, creating an electrical system impervious to outside elements.

In larger sizes, *Silco-Flex* insulation is used. In this system, silicone rubber is vulcanized into a homogeneous mass to form a flexible, moisture and heat resistant, void-free dielectric barrier around coils and leads.

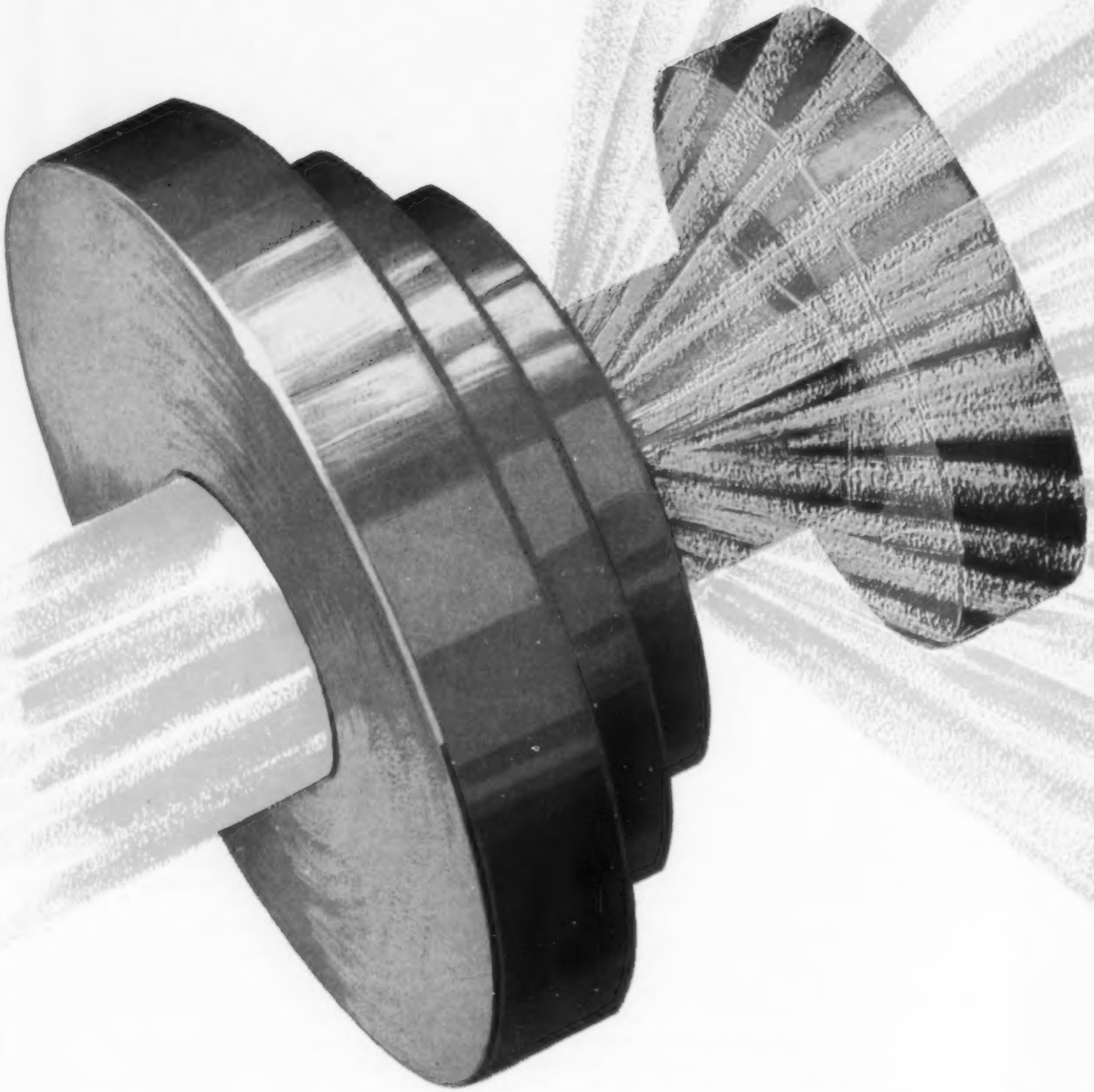
Both of these insulation systems are unsurpassed. Proof? An encapsulated motor ran for hundreds of hours at full load in a 4% brine solution.

Find out more about new economies in motors from your A-C representative or distributor, or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin. *Silco-Flex and Super-Seal are Allis-Chalmers trademarks.*

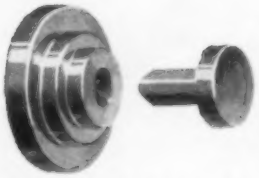
ALLIS-CHALMERS

A-5802

FOR THE MACHINERY PART



THAT TAKES THE BEATING



Liquids forced at high pressure through restricting valves—of HAYNES STELLITE alloy! That's the modern way by which hundreds of products are homogenized today, to make better dairy, chemical, food, and textile products, to name a few.

HAYNES alloys have been a standard material for homogenizer valves for 25 years. Valves that remain free from roughness, porosity, sharp corners, pits. Valves that retain their dimensions where pressures may reach 15,000 psi, and liquid velocities exceed 30,000 ft. per minute. Valves that keep products clean and free from contamination and give long service despite corrosive and abrasive conditions.

If design and production in your field call for tough metal parts, look into HAYNES alloys. There are more than 15 to choose from including HAYNES STELLITE cobalt-base alloys, HAYNES iron-base alloys, HAYSTELLITE cast tungsten carbide, and HASTELLOY nickel-base alloys. They are available as castings forgings, completely fabricated parts, or as sheet and bar stock. All parts can be furnished machined or ground to specified size and finish.

Our engineers will help you pick the right HAYNES alloy to resist practically any condition of wear, heat, or corrosion. For more information write for descriptive literature.

HAYNES Alloys *will do the job!*

HAYNES ALLOYS

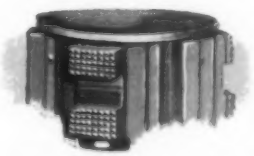
HAYNES STELLITE COMPANY

Division of
Union Carbide Corporation
Kokomo, Indiana

UNION CARBIDE

The terms "Haynes," "Haynes Stellite," "Hastelloy," "Haystellite," and "Union Carbide" are registered trade-marks of Union Carbide Corporation.

TYPICAL "HAYNES" ALLOY MACHINERY PARTS

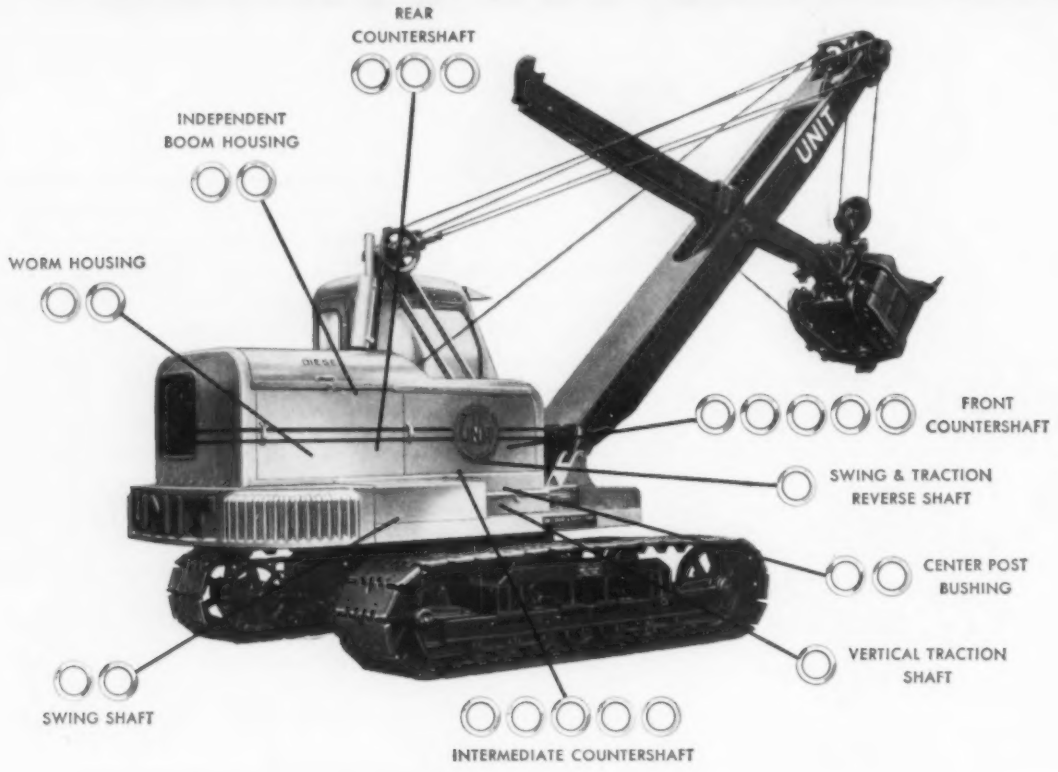


Chuck inserts of HAYNES STELLITE alloy last up to 50 days—2 shifts daily—holding heavy pieces during a cut-off operation.

Seam rollers on milk-can machines turn out 2 to 3 times as many cans now that the rollers are made of HAYNES STELLITE alloy.

Cutters and bed knives made of HAYNES STELLITE alloy stay clean and sharp for years while pelletizing extruded polystyrene.

NATIONAL OIL SEAL LOGBOOK



National Oil Seals used at key points throughout UNIT Crane & Shovel excavators

UNIT Model 1020 pictured above is a ¾ yard diesel excavator designed for maximum convenience and versatility in medium-duty applications. As in other UNIT excavators, National Oil Seals are installed at key points to retain lubricant, exclude dirt and water, and prolong life of bearings and assemblies.

In the UNIT 1020 Excavator, a total of 23 National Seals are employed in 9 basic subassemblies. These include front, rear and intermediate countershaft assemblies, swing traction reverse shaft, the turntable center pin assembly, vertical swing shaft, worm housing and traction shaft assemblies.

Grease seals used in the Model 1020 are of the National 50,000 series design, employing a spring-tensioned leather sealing member mounted inside a precision-made steel outer case. Shaft sizes range from 11/16" in the intermediate countershaft assembly to 8" on the turntable center pin. Similar use of National Seals is made in 11 other excavators offered by UNIT.

National Seals used in the UNIT Model 1020 are all of standard design; National offers over 2,500 different such seals or can design special seals for special requirements. Call your National Applications Engineer. He's listed in the Yellow Pages, under Oil Seals.

NATIONAL SEAL

Division, Federal-Mogul-Bower Bearings, Inc.
General Offices: Redwood City, California
Plants: Van Wert, Ohio, Downey and Redwood City, California

4956

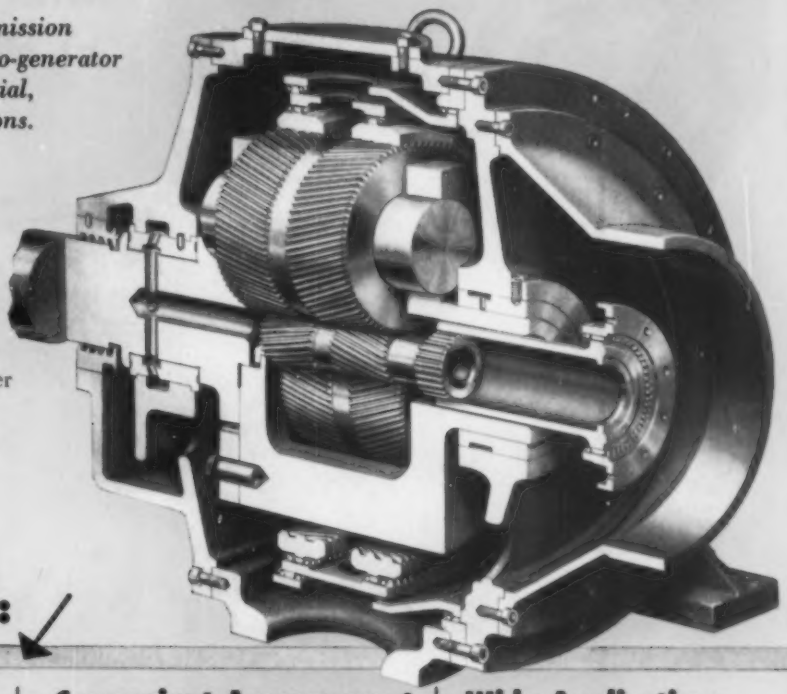
DE LAVAL-STOECKICHT
PLANETARY GEAR

...*for high speeds...high horsepower*

Proved in hundreds of installations abroad totalling over 3,000,000 horsepower—now available in America!

For all high torque power transmission applications such as pump turbo-generator and compressor drives in industrial, municipal and marine installations.

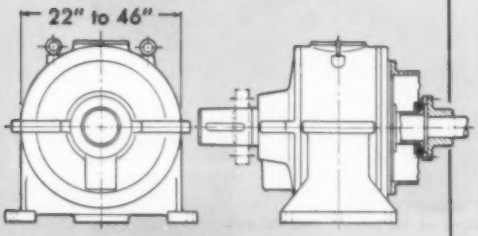
This cutaway view of the De Laval-Stoeckicht Planetary Gear shows how it provides flexibility for proper load distribution throughout the gear members. The thoroughly proved and tested design is completely reliable in transmitting high horsepower for high speed applications. • Highest efficiencies (98% or higher)...no high speed bearings...less friction losses.



Check These Advantages:

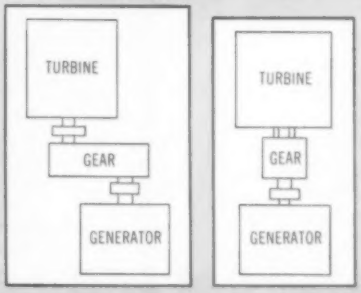
Small Size—Light Weight

Compact—low weight per hp. Sizes range from 22" to 46" in diameter, depending on horsepower requirements. Example: 5000 hp planetary unit weighs 1700 lbs. against 6000 lbs. for conventional gear.



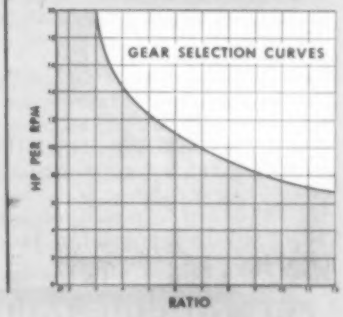
Convenient Arrangement

Co-axial or "in-line" arrangement of gear members takes up far less space than parallel axis gears of equivalent horsepower rating.



Wide Application

Capacity range shown in shaded area on chart below. For other applications, contact your De Laval Sales Engineer.



For further details, write for Bulletin 2400.

DE LAVAL *Steam Turbine Company*

801 Nottingham Way, Trenton 2, New Jersey

L491

T-J spacemaker cylinder

Quality Engineered

to give quality results

with Extras . . . at No Extra Cost!

You get more—much more—when you specify and use any of T-J's complete line of Spacemaker cylinders. The Spacemaker is engineered to give you better, more accurate, and longer service—offers, exclusively, many extras . . . that are STANDARD, AT NO EXTRA COST!

Designed to eliminate tie-rods, providing greater strength . . . saves space . . . reduces manhours and costs in all push-pull-lift operations. IMMEDIATE SHIPMENT in a wide range of styles and capacities, with 64,000 combinations. Write for Bulletin SM 155-3 with complete engineering details. The Tomkins-Johnson Co., Jackson, Mich.

T-J TOMKINS-JOHNSON
RIVITORS, AIR AND HYDRAULIC CYLINDERS, CUTTERS, CLINCHORS

METAL PISTON ROD SCRAPER . . . Standard at No Extra Cost!

NEW "SUPER" CUSHION FOR AIR . . . Standard at No Extra Cost!

CHROME PLATED CYLINDER BORES AND PISTON RODS . . . Standard at No Extra Cost!

ONE PIECE PISTON . . . Standard at No Extra Cost!

NEW "SELF-ALIGNING" MASTER CUSHION FOR HYDRAULIC USE . . . Standard at No Extra Cost!

NO TIE-RODS TO STRETCH . . . Standard at No Extra Cost!

STREAMLINED DESIGN . . . Oil Pressure to 750 P.S.I.—air to 200 P.S.I. Standard at No Extra Cost!

FORGED SOLID STEEL HEADS . . . Standard at No Extra Cost!

R/M PYROTEX REINFORCED PLASTIC PARTS RESIST HEAT TO 10,000°F

A few of many R/M Pyrotex parts are shown here. Pyrotex, a reinforced plastic, is molded, laminated or machined into precision parts for a wide variety of applications.

R/M Pyrotex parts may be the answer to your problem for low-cost structural parts capable of resisting temperatures as extreme as 10,000°F, while still meeting structural strength and thermal insulation requirements. Pyrotex has been proven outstandingly successful in industrial, automotive, aircraft, rocket and missile applications.

Some of the advantages of R/M Pyrotex parts: have high strength-to-weight ratios and good dimensional stability; take a smooth finish; can be mass produced to precision standards; are ideally suited for bushing, bearing, sealing, braking, and hundreds of other applications —all usually at substantial savings in production costs. Write today for complete data on R/M Pyrotex parts.

THE COMPLETE LINE OF R/M REINFORCED PLASTICS

If your design demands all of the following features, find out more about R/M Pyrotex parts

- Heat and flame resistance up to 10,000°F or more
- Chemical and water resistance
- Relatively isotropic
- High modulus of elasticity from low to high temperatures (6 x 10^6 psi)
- High strength from low to high temperatures (60,000 psi)
- Improved surface of end items
- Exceptionally good dimensional stability
- Little or no surface crazing
- Good insulation and thermal properties
- Low cost
- High strength-to-weight ratio

For further information, write for technical bulletin

R/M FIRST IN FRICTION

RAYBESTOS-MANHATTAN, INC.

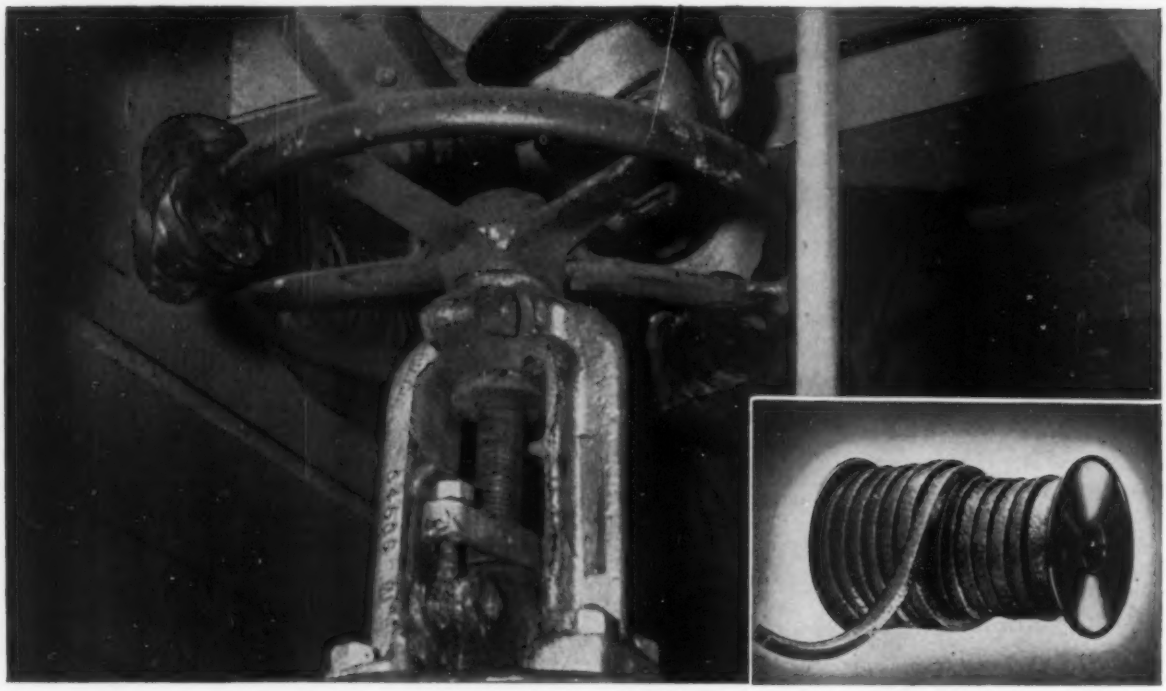
EQUIPMENT SALES DIVISION: Bridgeport, Conn. • Chicago 31 • Cleveland 16 • Detroit 2 • Los Angeles 58

RAYBESTOS-MANHATTAN, INC., Brake Linings • Brake Blocks • Clutch Facings • Sintered Metal Products Industrial Adhesives • Mechanical Packings • Asbestos Textiles • Industrial Rubber • Rubber Covered Equipment • Engineered Plastics • Abrasive and Diamond Wheels • Laundry Pads and Covers • Bowling Balls

CUT COSTS, IMPROVE DESIGN AND PERFORMANCE WITH R/M PRODUCTS

PACKINGS

Complete information on the packings shown and many others is given in free booklet. Send for it today.
Packing Division, Raybestos-Manhattan, Inc.
Passaic, N.J.



Recommended for hot oil and high pressure steam: R/M High Temperature Valve Stem Packings

R/M High Temperature Valve Stem Packings—reliable solution to your hot problems

Today's boilers produce more heat and more pressure. They also produce more packing problems. To get reliable performance at temperatures as high as 1000°F or higher, specify R/M High Temperature Valve Stem Packings.

R/M's experienced engineers designed these packings to meet your toughest present and future needs. They eliminated practically all of the organic materials which break down under heat. The result is a packing which provides outstanding heat resistance and low volume loss. Solid lubricants are ground in during manufacture—you will find thorough compounding no matter where you cut into the packing. R/M uses braided asbestos—reinforced with Monel or Inconel wire to give you maximum extrusion resistance.

R/M High Temperature Valve Stem Packings are available in several types, for use with steam, hot oil, or hot gases. One of these types is ideal for your requirements. Call on the R/M engineers for their specific recommendations.

The complete R/M line includes packings and gasket sheets for use with gases, water, steam, oil, chemicals, solvents and food products. Feel free to call on R/M's experienced engineers for help in your packing problems.

R/M

Brake Blocks, Linings and Clutch Facings

Mechanical Packings and Gaskets

Abrasive and Diamond Wheels

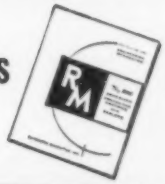
Industrial Drive Belts

Industrial and Automotive Hose

Conveyor Belts

SPECIALISTS IN ASBESTOS, RUBBER, SINTERED METAL, ENGINEERED PLASTICS

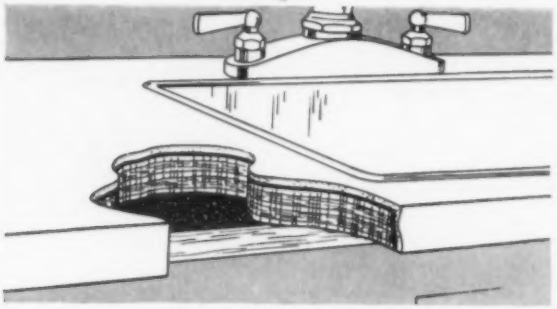
ADHESIVES



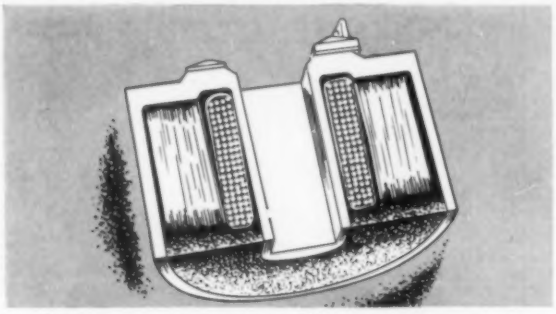
Send today for free copy of R/M Bulletin No. 700 on Ray-BOND adhesives, protective coatings and sealers.
Adhesives Department
Raybestos-Manhattan, Inc.
Bridgeport, Conn.

RUBBER

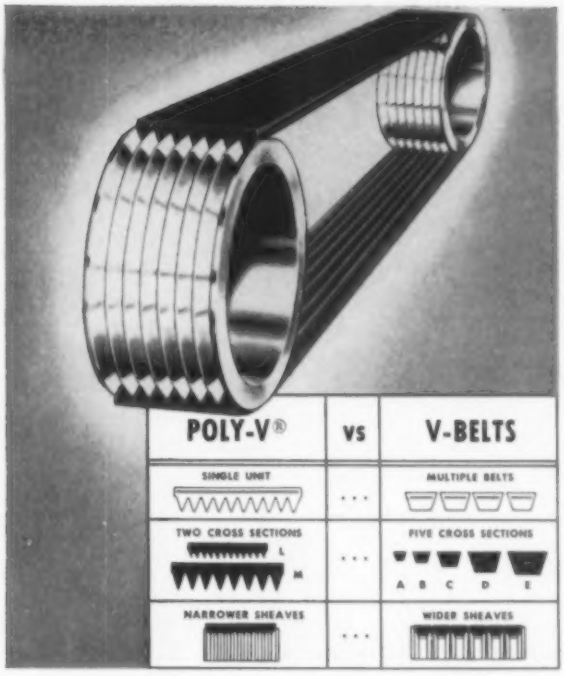
Write today for free booklet shown: full details on a wide variety of industrial rubber products.
Manhattan Rubber Division
Raybestos-Manhattan, Inc.
Passaic, N.J.



Bonding cabinet top to base



Sealing hundreds of wires with an R/M encapsulating compound



R/M Ray-BOND® Adhesives for faster production—lower costs

Ray-Bond Adhesives, tailored to the performance needs and the fabrication techniques of the individual manufacturer, are meeting widely varied requirements in products as diverse as aircraft engines and submarine cables, band saws, textiles and other porous materials. Adhesive bonding can cut your assembly costs, speed production, and simplify fabrication problems. It eliminates rivets and other fasteners, provides better heat conductivity, increases the life of friction members, and permits more effective bonding of dissimilar materials.

R/M offers you the benefit of its more than 20 years of experience with bonded assemblies for varied applications. Feel free to call on our engineers for help.

Put more power in less space with R/M Poly-V® Drive

Unique design of its single, parallel V-ribbed belt gives R/M Poly-V Drive* *twice* the tractive surface of a conventional multiple V-belt drive. This means Poly-V delivers up to 50% more power in the same space as a V-drive or equal power in as little as ⅓ the space! R/M Poly-V permits a more compact, lighter weight drive with less shaft overhang. Just two belt cross sections meet *every* heavy duty drive design requirement.

For light duty, single groove drive applications specify R/M FHP V-belts. Patented micro-positioned strength member and density controller make these the smoothest running V-belts made. Run quieter, cooler—and with less vibration. They're ideal for all kinds of motorized appliances, pumps and power tools. Whatever the drive design problem, rely on R/M specialists for the solution.

*Poly-V is a registered Raybestos-Manhattan trademark.

RAYBESTOS-MANHATTAN, INC.

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Rubber Lined and Covered Equipment

Sintered Metal Friction Elements

Asbestos Textiles

Industrial Adhesives

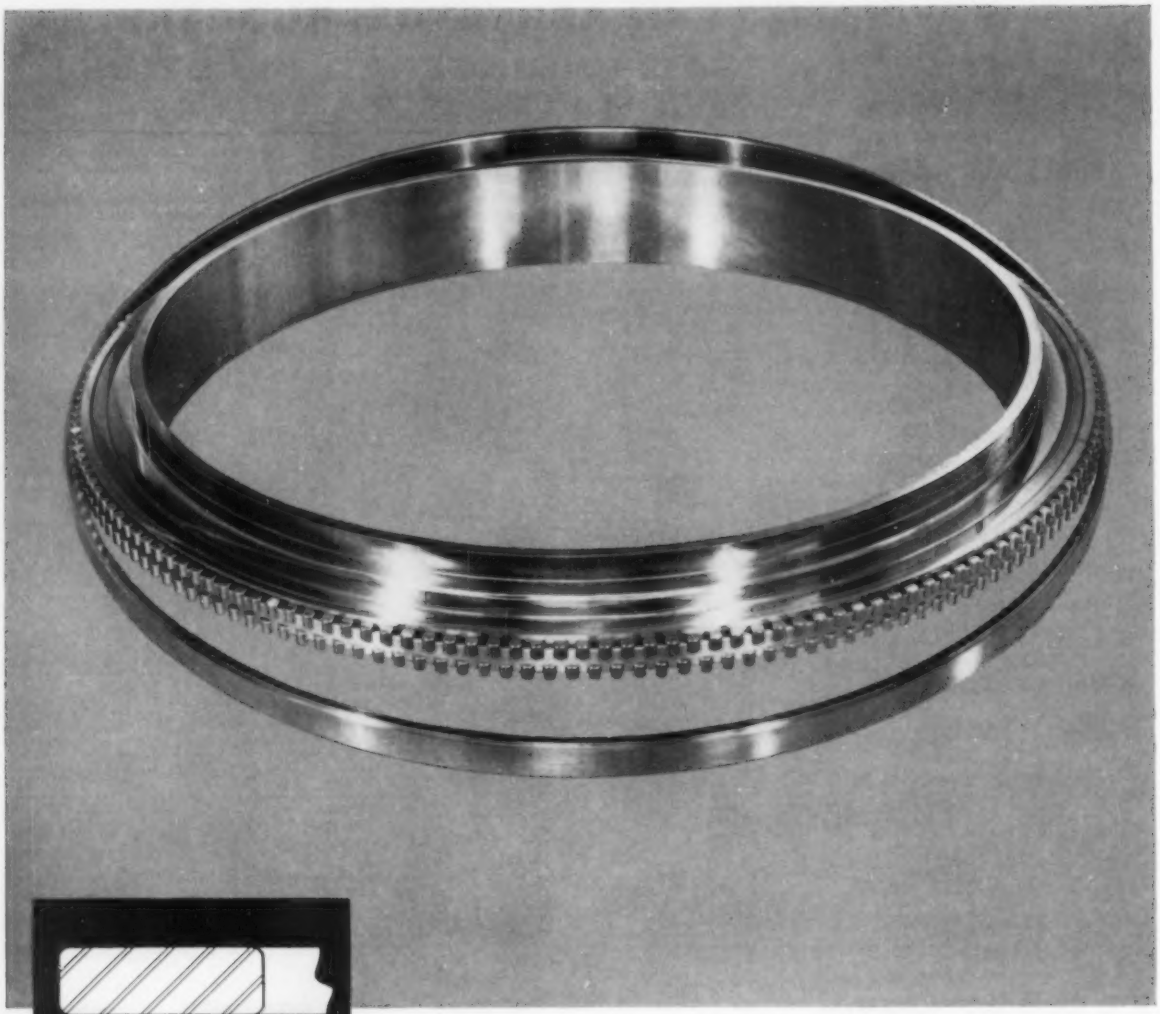
Teflon Tape, Packings, Sheets, Rods, Tubes

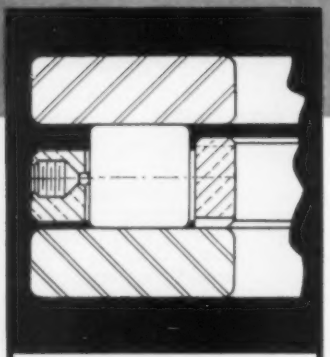
Engineered Molded Rubber and Plastics

R/M

CIRCLE 121 READER SERVICE CARD

CIRCLE 122 READER SERVICE CARD





Running mate of the Torrington Radial Roller Bearing pictured is this Torrington Cylindrical Roller Thrust Bearing 52 in. OD, assembled face runout 0.0004 in., capacity 222,000 pounds at 100 rpm.

A picture of precision... 57.500 inches in diameter!

Here is an ultra-precision Torrington Radial Roller Bearing, custom-built for Wickes Machine Tool Division's 48" Center Drive Profile Lathe.

Almost five feet (57.500 in.) in diameter, it has a total inner race runout of only 0.0005 in. Its 344 rollers are held uniform in diameter within 0.00005 in. Radial capacity is 318,000 lb. at 100 rpm. Rollers are staggered in a one-piece, fully machined bronze cage for precise guidance and cool running. The bearing bore is tapered one inch per foot, and carefully mated to the spindle which was also ground by Torrington.

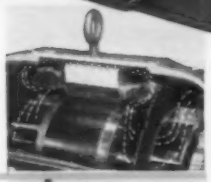
Such precision is possible only through specialized equipment and highly practiced skills—the same that lie behind the quality of every Torrington bearing, standard or special. Not every bearing order calls for such precision—but each is given the extra measure of care that makes Torrington quality a byword in industry. **The Torrington Company, South Bend 21, Ind.—and Torrington, Conn.**

TORRINGTON BEARINGS

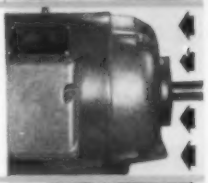
District Offices and Distributors in Principal Cities of United States and Canada

SPHERICAL ROLLER • TAPERED ROLLER • CYLINDRICAL ROLLER • NEEDLE • BALL • NEEDLE ROLLERS • THRUST

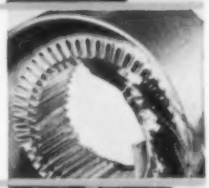
NEW R&M Re-Rated Series 254U All-Weather Motors



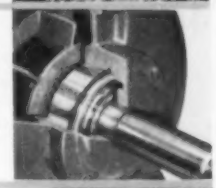
"straight through" dual-sweep ventilation eliminates "hot spots"



full height end head protection



Mylar® insulation increases motor life



bearings easily inspected by removing cover plate

permanently numbered leads simplify installation and maintenance

®DuPont registered trademark.

Premium Performance

. . . at standard motor prices

R&M Series 254U Motors help pay their own way from the minute you flip the switch! They stoutly resist any hostile environment — moisture, dirt, heat, acid or alkaline fumes — and so live longer. They have push-pull ventilation that won't let dirt settle and keeps motor internally cool — and so perform with full, brisk efficiency. Their oversize bearings are quick and easy to inspect and relubricate — so your maintenance costs dwindle.

This long, trouble-free, vigorous motor life is what R&M means by "Premium Performance" — an extra reward in service and savings every R&M motor offers. These and other big, money-saving advantages shown at left cost no more . . . R&M motors carry standard motor prices!

Write today for R&M Bulletin 520-PRE

Robbins & Myers build motors from 1/200 to 200 horsepower

ROBBINS & MYERS, INC.

SPRINGFIELD, OHIO / BRANTFORD, ONTARIO

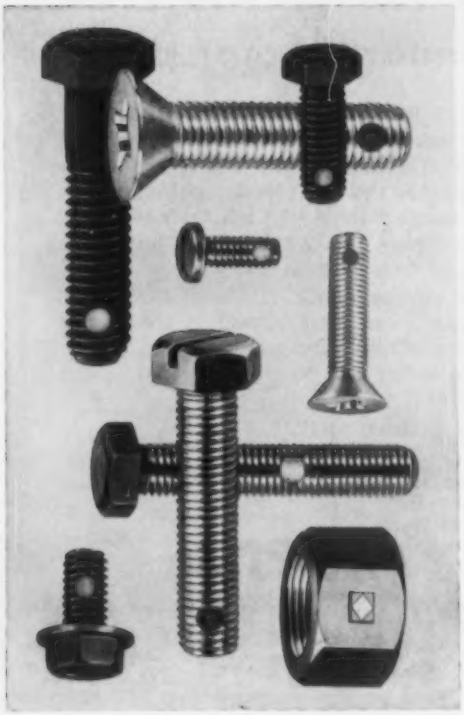
"We've built a better mouse trap with REPUBLIC ELECTRO PAINTLOK SHEETS"

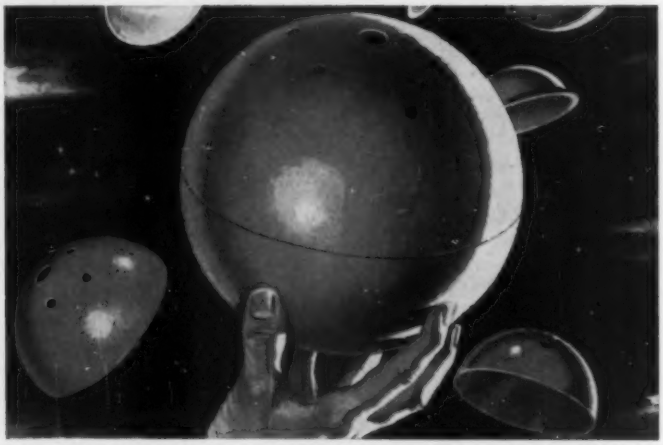
"If we expected the world to beat a path to our door," continues Mr. Coughanor, "we knew every detail of design and material in the Self Sett Trap had to be exactly right. As a result, extensive tests have been conducted which prove design efficiency. And experience has proved Republic Electro Paintlok is the best steel sheet we can buy for economy, long life, and excellent paint-holding qualities. The combination of these factors gives us the best, safest, most foolproof product on the market."

This enthusiasm for Republic Electro Paintlok® is echoed by many other product manufacturers faced with a wide range of forming and application problems. The reason is the chemically treated zinc surface of Republic Electro Paintlok which leaves the mill in prime condition for painting, and won't crack, flake, or peel under any forming operation permitted by the base metal.

These features of Electro Paintlok protect the applied finish of completed products—holding it tightly and restricting corrosion to the point of damage if it should be scratched through.

If you want to "build a better mouse trap" in your product field, it will pay you to get all the facts on versatile Republic Electro Paintlok. Contact your Republic representative or mail coupon.





BETTER OVER-ALL PERFORMANCE WAS MADE POSSIBLE through the use of Republic Titanium in the manufacture of these hemispheres by Alloy Products Corporation, Waukesha, Wisconsin. Used for special aeronautical applications, completed spheres provide light weight without impairing safety; strength to contain 2,000 p.s.i.; extreme corrosion resistance to chemically active contents. Beyond providing product advantages, Republic Titanium is easy to draw, pierce, and weld. Little change in fabricating procedure is required as compared with other construction materials. Send coupon for data.

BETTER SERVICE FROM BOLTED ASSEMBLIES subject to impact and vibration can be secured when they are fastened with Republic Nylok® Bolts and Nuts. The resilient nylon pellet imbedded in the body of bolt or nut forces a tight metal-to-metal lock between opposite mating threads. Pellet is unaffected by age or moisture and permits both adjustment and re-use without loss of holding power. Lock is secure even if fastener is not seated. For details, send coupon.

says Mr. E. S. Coughanor,
President, Self Sett
Mouse Trap Company,
Cleveland, Ohio

OPERATION OF THE SELF SETT MOUSE TRAP, as indicated here by Mr. Coughanor, depends on both ingenious design and corrosion resistant materials. A series of automatic doors and pivoted ramps leads the rodent to his destruction in a tank of water. The special coating on Republic Electro Paintlok holds painted finish securely to provide long-term corrosion resistance required to maintain trap operating efficiency.

BETTER COAL "FINE" RECOVERY RATE WAS SECURED when the cotton fabric on this coal-cleaning plant disc-type filter was replaced with a finely woven mesh of Republic ENDURO® Stainless Steel. In addition to doubling efficiency, ENDURO provides far longer service. Republic ENDURO is available in all standard forms, finishes, and analyses. For full information, mail coupon.

REPUBLIC STEEL

World's Widest Range of Standard Steels and Steel Products

REPUBLIC STEEL CORPORATION
DEPT. PE-5251
1441 REPUBLIC BUILDING • CLEVELAND 1, OHIO

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☐ Electro Paintlok ☐ Titanium
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Address _____

City _____ Zone ____ State _____

For Longer Service Life...

Motor Start with Built-in Bleeder

Motor Start

Motor Run

Specify

Mallory

Motor Start and Run

Capacitors

MALLORY—pioneer in capacitors—manufactures a complete line of dependable motor start and motor run units for every standard requirement.

Newest cost-saving additions to the line are Mallory motor start capacitors featuring a built-in bleeder resistor, deposited on the top plate between the terminals . . . and oil filled motor run capacitors in new ratings of 150 and 175VAC, which make possible reduced run capacitor costs.

Mallory Electrolytic Motor Start and Paper Dielectric Motor Run Capacitors are extremely dependable. They offer longer service life and indefinite shelf life . . . feature moisture-proof construction . . . and offer a complete selection of capacity and voltage ratings and physical sizes.

The Mallory Representative will be glad to supply any required data, or arrange for an application engineering discussion to help meet your specific needs.

Serving Industry with These Products:

Electromechanical — Resistors • Switches • Tuning Devices • Vibrators
Electrochemical — Capacitors • Mercury and Zinc-Carbon Batteries
Metallurgical — Contacts • Special Metals • Welding Materials

Parts distributors in all major cities stock Mallory standard components for your convenience.

Expect more...get more from

P.R. MALLORY & CO. Inc.
MALLORY

P. R. MALLORY & CO. Inc., INDIANAPOLIS 6, INDIANA

Rubber Parts
engineered to your product by PRECISION

THE production of rubber seals, poppets and diaphragms of intricate shape and form – especially engineered to meet individual product requirements – is a Precision specialty. Parts are compression molded for uniform density ... have maximum resistance to compression set ... meet military-standards and specifications ... solve close tolerance problems.

If you're looking for the answer to a heat, compression, friction, or fluid resistance sealing problem, ask for the services of a recognized sealing specialist – the Precision engineer.

Precision "O" Rings, Rubber and Rubber Bonded-to-Metal Parts

Precision Rubber Products Corporation

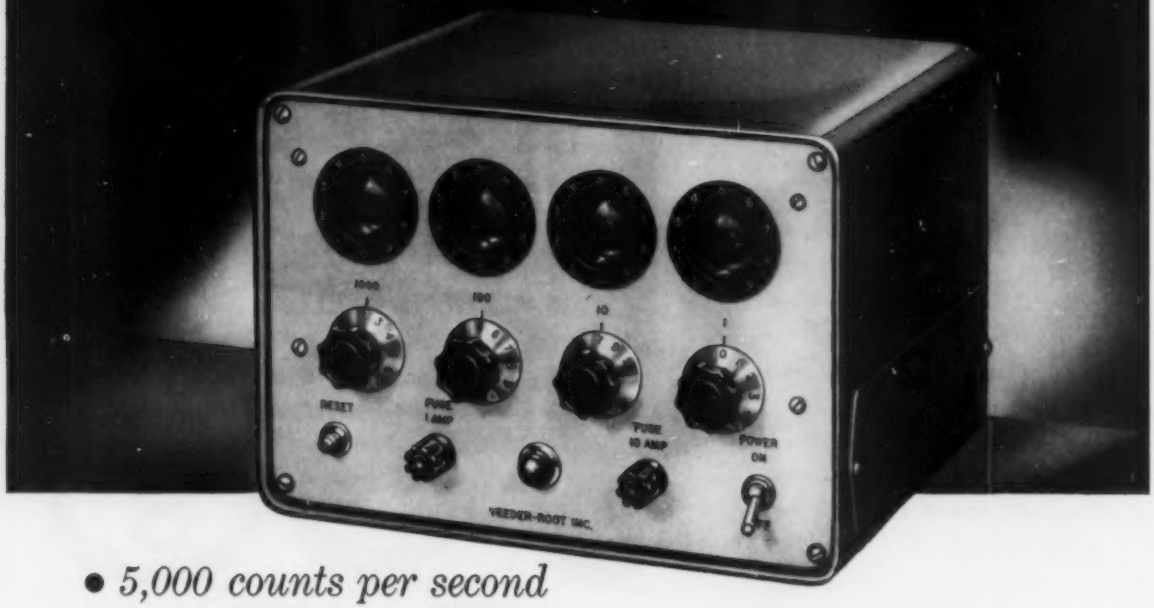
"O" Ring and Dyna-seal Specialists

3110 Oakridge Drive, Dayton 7, Ohio

Canadian plant at: Ste. Thèrése de Blainville, Québec

NEW

TRANSISTORIZED PREDETERMINING COUNTERS



- *5,000 counts per second*
- *Instantaneous recycling*
- *Increased reliability*
- *Industrial design*

A versatile group of transistorized production counters designed for industrial applications. Any number of decades can be furnished depending upon your requirements.

Can be operated by non-technical help merely by setting the selector knobs to the pre-set quantity within the range of the instrument. These counters are ideal for batch control, sequential predetermining, or accurate length control in such applications as packaging, coil winding, slitting, stacking and material handling.

The use of transistors means that heat — the enemy of reliability — has been eliminated. This reduces warm-up time and increases dependability. Printed circuits and simplified wiring further insure long trouble-free operations.

Standard counters are completely enclosed in attractive industrial cases, but can also be supplied without enclosures for panel mounting. A photo head to actuate these counters can be furnished in many configurations. Batch totalizers with push-button reset and special modifications of basic components can be furnished on request.

This is your complete package for predetermining counting at high speeds. Send for your copy of the new specification bulletin outlining the complete range of the series 1604 counter line today.

Veeder-Root
INCORPORATED
Hartford 2, Connecticut

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Los Angeles • San Francisco • Montreal • *Offices and Agents in Principal Cities*

CIRCLE 129 READER SERVICE CARD
CIRCLE 130 READER SERVICE CARD→

d'Arazien

Alcoa puts the metal where you want it

Before you read on, blink your eyes. In the time it took to do that, this man has produced an entire automotive grease gun body—complete with external ribs; solid end; smooth, seamless interior; and go-to-market external finish.

Sound too easy? No! We can make round, oval, square and irregular parts the same way. Finished parts—with the strength of forgings—with tolerances down to plus or minus 0.005″—with a smooth, corrosion-resistant finish of about 125 microinches. A clear case of putting the metal where *you* want it. The cost of tooling for impacts is surprisingly low, too. A good rule to remember is that virtually any closed end or tubular design should be considered as an Alcoa® Impact.

In impacts, as well as forgings, castings, extrusions and screw machine parts . . . Alcoa puts the metal where you want it. A call to Alcoa can mean fewer rejects or ingenious design solutions . . . less waste in production or a product that sells faster. Start now; write for Alcoa Up-to-Daters, a file of design tips on Alcoa Engineered Products. Aluminum Company of America, 1999 Alcoa Building, Pittsburgh 19, Pennsylvania.

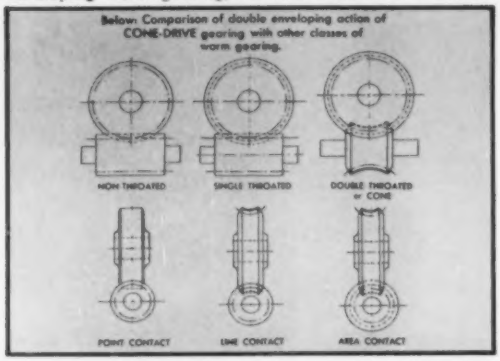
ALCOA ALUMINUM

Alcoa puts the metal where you want it — in castings, forgings, extrusions, screw machine parts and impacts.

ALCOA THEATRE
FINE ENTERTAINMENT
ALTERNATE MONDAY EVENINGS

How to get the most out of Worm Gearing

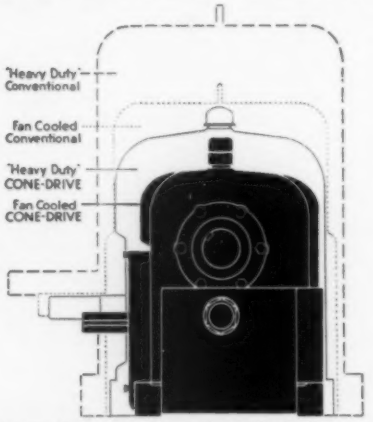
If a right-angle drive is needed in your product and you require maximum capacity for your dollar, then the Cone-Drive double-enveloping type will give it to you. The sketch below shows the apparent advantages of Cone-Drive gearing as compared to other worm gear types. Double-enveloping worm gearing, the most modern and efficient


Below: Comparison of double enveloping action of CONE-DRIVE gearing with other classes of worm gearing.
NON THROATED
SINGLE THROATED
DOUBLE THROATED or CONE
POINT CONTACT
LINE CONTACT
AREA CONTACT

form, has straight-sided teeth in both worm and gear. Both elements of Cone-Drive are throated and envelop each other, providing a multiple tooth area contact. This means greater load-carrying capacity than is possible with any other type of worm gearing.

Speed reducers and gearmotors with Cone-Drive double-enveloping worm gearing are unusually compact and powerful drives that handle shock loads with ease. Yet, they provide power transmission smoother than that of hydraulic systems. Another advantage, unique to double-enveloping worm gearing, is their ability to regenerate themselves when wear occurs. Both worm and gear tend to reproduce the correct form in the other when wear occurs.

Double-enveloping worm gearing is available from Cone-Drive Gears in complete lines of gearsets, speed reducers and gearmotors. Gearsets are stocked in center distances from 2" thru 24", capable of handling loads from fractional to over 1600 horsepower. A complete line of mountings for gearsets is also stocked.



Double-enveloping worm gearing with its "wrap-around design" requires shorter center distances than cylindrical worm gearing to handle the same loads. As a result, Cone-Drive speed reducers have smaller housings with corresponding savings in weight and space. Bulky gear trains can often be replaced with a single Cone-Drive speed reducer or gearset.

TEAR OUT AND MAIL IN FOR COMPLETE DATA

DOUBLE-ENVELOPING WORM GEARSETS | DOUBLE-ENVELOPING WORM GEAR SPEED REDUCERS | DOUBLE REDUCTION WORM GEAR SPEED REDUCERS | DOUBLE-ENVELOPING RIGHT ANGLE GEARMOTORS

CONE-DRIVE GEARS
DIVISION MICHIGAN TOOL COMPANY
7171 E. McNichols Road • Detroit 12, Michigan
Telephone: TWinbrook 1-3111

Please send me information on following:

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DEVELOPMENTS TO WATCH...

Blueprint specifications for cleanliness . . .

. . . are being developed for products ranging from electron tubes to heavy-duty engines. It used to be considered enough to say "wash thoroughly" or "maintain clean." But today, efficiency of parts-cleaning specifications can affect basic part design. Accurate, quantitative specifications are needed. Engineers at Bell Labs find, for instance, that removal of chemical contaminants in the junction area of a silicon rectifier increases its yield tenfold. Thermionic emission of a traveling-wave tube can be tripled by specifying cleaning methods aimed at eliminating contaminants. Removal of carbon from thyratron anodes makes it possible to operate tubes under stringent conditions.

At Bell Labs, dirt and contaminants are now divided into five groups:

1. physical contaminants (dust, lint, metal)
2. ionic contaminants (water-soluble residues from acid dips and electroplating solutions)
3. oils and greases
4. chemical contaminants (oxides, sulfides, etc.)
5. gaseous contaminants (including those generated in the device as well as those adsorbed or absorbed on the materials of construction).

More complex parts . . .

. . . for higher temperature service are promised by two improvements in graphite technology unveiled by Minnesota Mining. One is an impervious silicon-carbide coating said to provide excellent oxidation resistance, good adhesion, and very good abrasion resistance. The other is a new process for bonding graphite, also making use of "special silicon-carbide compositions," that is "far superior to any previous techniques."

Company spokesmen say the coating has allowed subjecting graphite parts to temperatures as high as 2700 F for several hundred hours without measurable oxidation. They have withstood immersion in boiling acids (including aqua regia), and even repeated short-term bursts of oxidizing gases at temperatures above 5000 F.

As to the bonding process, 3M engineers say it produces specimens that are "stronger than the material itself."

Applications foreseen for graphite parts coated and bonded by the new processes range from high-temperature thermocouples to nuclear reactor fuel elements. Commercial production will be handled by American Lava Corp, 3M subsidiary.

Car battery of new design . . .

. . . scheduled for introduction this fall, features individually removable polystyrene plastic cells in a polyethylene plastic frame. Advantage of the separate-cell design, the manufacturer says, in addition to the fact that defective cells can be replaced at moderate cost, is that freer flow of air around the cells is possible. This minimizes danger of overheating. Also new, according to the company, is use of powdered selenium in the battery acid (added in the form of a selenium-lead oxide mixture) to "prolong cell life by reducing the shedding of active particles from the battery plates . . . and speed battery charging by reducing electrical resistance."

The new battery will be marketed by Scranton "Cellomatic" Battery Corp, Archibald, Penna. Retail price of a 6-v automotive battery will be $29.95; replacement cells, $9.95 each. Marine and industrial models are to be made available later.

Replacement cell is installed in new battery (photo) simply by unscrewing posts and lifting off top of frame.

DEVELOPMENTS

TO WATCH...

Control of friction and wear . . .

. . . is getting a full-dress discussion at the American Chemical Society meeting in Chicago. Studies reported by both government and industry engineers promise new materials and new designs that may go far toward easing present problems.

A. M. Bueche and D. G. Flom of the GE Research Laboratory, for instance, describing tests of the lubricated sliding of metals on polymers, indicate the coefficient of rolling friction is related to the bulk mechanical properties of the materials and that "under the conditions of lubrication most commonly encountered, the sliding friction may be expected to consist of the sum of the physical property contribution and a shearing-energy term."

Recent research on gas lubrication, reported by D. H. Burkley and R. L. Johnson of Lewis Flight Propulsion Laboratory, confirms earlier reports on the value of this approach to high-temperature lubrication problems (*PE*—Nov 25, '57, p 100). They note that "reactive gases such as sulfur hexafluoride and Freon-type compounds are capable of providing effective boundary lubrication with several alloys at temperatures from about 70 to 1200 F," under the experimental conditions, at least.

There is much news, too, in basic laws of adhesion that govern the performance of materials under load. Defining a *coefficient of adhesion* as the force required to break metals apart, divided by the normal load used to push them together; and noting that this coefficient seems independent of roughness, hardness, and time factors, provided the tangential load is great enough, Bell Labs scientists formulate two empirical "laws of adhesion":

1. The median adhesive force is proportional to the normal applied load.

2. The adhesive force is independent of the apparent area of contact.

As they point out, these parallel the laws of friction. They also note that the adhesive force, too, is reproducible only in a statistical way: as the median of a log-normal distribution of a set of experimental determinations.

New fan design . . .

. . . that combines the advantages of centrifugal and axial flow is being readied by Torrington Mfg Co for introduction this fall.

The blades have an axial shape at the intake, but gradually change to take on a centrifugal type configuration by the time the discharge point is reached. Aim of the new mixed-flow design is to satisfy the need for a fan in the fractional horsepower range that can be used in heating and air conditions. (For additional details, see forthcoming issue.)

Resistive elements of new design . . .

. . . for service at temperatures to 500 F can be produced by taking advantage of thin chromium-silicon films, says a Battelle research report.

Vapor-deposited films of this type can be given an electrical resistance ranging anywhere from several hundred to several thousand ohms per square, and the temperature coefficient of resistance can be controlled to within a few hundred parts per million per degree of temperature change. Furthermore, the report notes, the coatings themselves are hard and abrasion resistant, and not adversely affected by temperature cycling.

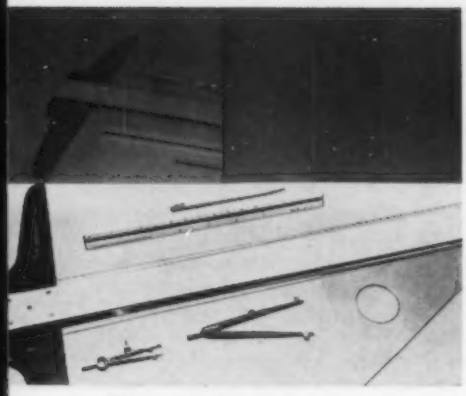
Further study is needed to develop the full potential of these films, but Battelle researchers suggest they may have additional applications as magnetic and thermoelectric elements.

A performance standard for brake linings . . .

. . . based on a coefficient of friction, is sorely needed, makers and users agree.

Speaking at the West Coast SAE meeting, J. V. Bassett, chief engineer, Heavy Duty Truck & Bus Brake Linings Div, Raybestos-Manhattan, said, "Some unit of standard friction value must be maintained if any semblance of balance is to be achieved, particularly on interchange units."

H. A. Dozier and R. W. Kupp of Consolidated Freightways second the motion, pointing out that a standard method of rating the coefficient of friction and fade characteristic of lining materials could be set up through the American Friction Materials Institute, the ASTM, or the SAE. Both papers are still open for written discussion (until Oct 1). Perhaps someone will provide the spark—it seems all that's needed to get the standardization program under way. —ARG



Gleam of lacquer . . .
developed by GM for its 1959 cars is shown in this comparison of two weather-tested panels: reflection of drawing instruments from panel (left) finished with new car paint, and from panel (right) covered with conventional lacquer.

Develop Longer-lasting Car Paint

DETROIT—Fisher Body Div, GM, says it has developed an acrylic lacquer automobile paint that retains gloss three times longer than ordinary finishes and is 22 times as colorfast. Reflection meters, the company says, show that the new finish retains as much as 75% of its luster without polishing—after a year's exposure to sun and weather. It is said to be resistant to stains from oil, grease, road tars, tree leaves and blistering from prolonged rain or hurricanes.

Because the acrylic lacquer settles rapidly, Fisher Body has had to add $1 million of new equipment for applying it. Paint is circulated through ¼-in. plastic tubing to the spray gun and the unused portion is returned to the mixing tank through smaller plastic tubing. The continuous flow of paint keeps pigments in suspension and prevents off-color jobs.

In preparation for lacquering, car bodies first are subjected to six rust-proofing processes and force-dried for 14 min. at 300 F. Then a corrosion-resistant primer surface is applied and baked—this time for an hour at 300 F—sanded, and baked again for 14 min. at 300 F. Finally, four successive coats of the lacquer are applied and baked at 200 to 210 F for 30 min. An abrasive polishing winds up the job.

Money, Glamor, Challenge Decide Today's Engineer Student on Future

NEW YORK—Engineering students today are attracted more and more to the newer fields of engineering like missiles and rockets—not only because of the glamor aspects, but also because of salary considerations and the inherent challenges posed. This was the consensus of key educators queried this week by PRODUCT ENGINEERING.

Farrell McGhie, Associate Dean of the School of Engineering at Stanford University; "The best students are interested in new fields like missiles. The frontiers of learning are there—the challenge is there. Another reason why those fields are popular is because they offer better salaries.

"In electrical engineering 15 years ago, everything was 60-cycle power. Now the only students interested in such matters are from India, Africa and other areas just getting into the stage we were in years ago. A sign of the times—our Ryan High-voltage Laboratory was viewed with awe 25 years ago; today it's being transformed into a nuclear engineering lab, and we're closing out high-voltage research.

"But students are not overspecializing. Today's engineering graduate is more flexible. If one field becomes overloaded and salaries go down, he can move into another. That's because our training is broad, ¾ of our engineering course is the same for all departments.

"This interest in new fields is true of mechanical engineers (nuclear and heat-transfer) and metallurgical engineers (new metals for missiles) as well as for electrical engineers."

GLAMOR LURES HIGH SCHOOLERS

Dean McEachron of Case Institute: "The so-called glamor appeal of missile, rockets and atomic power can't be applied to college students. Rather, this appeal is reflected in high school students persuaded to seek a career in engineering or science. By the time the college engineering student is a junior or senior he has a more sophisticated attitude. He knows the fields are new and accepts the challenge as one requiring new applications to old fundamentals."

Fred Benson, Dean of Engineering at Texas A & M: "We notice that our engineering enrollment varies with the amount of attention each field is getting in the news. For instance, the petroleum industry is doing well, and gets favorable comment in the newspapers, so our petroleum engineering enrollment goes up. The same for aeronautical engineers.

"Actually, I think there is more correlation with salary possibilities than the attendant glamor of a field."

A Southern Methodist University Engineering Department spokesman: "There certainly has been a trend in the last few years for engineering students to be attracted to the more glamorous jobs—particularly among beginning engineer students. As they get older the glamor doesn't count as much.

"However, just as important is the money angle. Frequently the less glamorous jobs, such as work for a public utility, will have a less attractive price tag. So when the student sets up his course of study, he angles for the better-paying job such as in

Space ship engine . . .
Republic aviation engineers test a magnetic-pinch-plasma engine that in space flight may possibly produce energy equal to 250 hp to propel a 35,000-lb space ship on a 34,600,000-mi flight to Mars. In the high-vacuum chamber (top left), an electrical current, generated in the lower section, acts on a heavy gas such as liquid oxygen and turns it into plasma which is pinched by a magnetic field, then shot out of a nozzle at extremely high velocities.

aircraft which is also more glamorous."

Ralph G. Owens, Dean of Engineering at Illinois Institute of Technology: "I believe the attraction of the glamor industries such as missiles-aviation has affected mainly the electrical engineering group. Here the student has the choice of selecting the power field or electronics–and power has been bypassed more or less. Also, the number of students going into electrical engineering exceeds the number in mechanical engineering; a few years ago the reverse was true."

Dr. John A. M. Lyon, Chairman of the Department of Electrical Engineering at Northwestern University: "There is no question but what electronics has taken the play away from the power industry. I am glad to see good men go into any field–missiles, power, controls–and I hope the power industry will make a more concerted effort to hire young engineers and focus more of its attention on research."

Dr. George T. Harness, Dean of the College of Engineering at USC: "There has been a pronounced shift of engineering interests but it took place a long time ago, as far back as the post-World War II period. The fields of engineering have increased enormously, the time interval between discovery of a principle and its application has been narrowed. Today we can teach only fundamentals, leaving industry to show the practical way."

Portable color TV system . . .

Transistorized, portable color-television system, requiring no more power than amount supplied by an automobile battery, has been developed by RCA for closed-circuit applications. Using some 300 transistors helped cut weight of two units down to only 65 lb. Here, color camera (center) picks up image of specimen under microscope, displays it on monitor at right and standard color-TV receiver at left.

Military, Civilians in Heated Debate on Weapons System Control

Los Angeles—Who should retain administrative authority over development of weapons systems? This problem, one of the knottiest of postwar vintage, came up for heated discussion at a recent WESCON panel session here–and it lasted until midnight. Key views were:

- **Airframe manufacturers held that future weapons will be essentially airframes with electronic components, hence the bailiwick of airframe people.**
- **The electronics representatives declared weapons systems are becoming essentially electronic systems in flying packages.**
- **The Air Force, in the view of Col. Edward N. Hall, Ballistics Missile Div, believes the military instead of industry should retain control over such development. The speaker said assigning responsibility to industry under weapons-systems management contracts has not been successful on big projects.**

HERE'S HOW THEY ARGUED:

Boeing–Its weapons-systems project manager, George Stoner, said the prime contractor is in constant danger of becoming a technical anachronism –builds a big organization, then discovers the weapons system is obsolete. In 10 or 15 years, defense concepts may change so that discrete geographical areas no longer exist. A private company has difficulty evaluating future military posture as a guide for present conduct of business. Strategy of industry today is to consider how the military will organize, then guess how contracts will come.

To a suggestion from the audience that electronics firms are more capable of superintending weapons development than other industries because electronic products themselves are systems, Stoner replied: "Systems are something like Copernicus' system of galaxies–wheels within wheels. Systems integration in aircraft is really a sub-problem. Determining the mission and capability of a weapon, is an echelon higher–here the airframe people work with top-level military personnel. Equipment integration is not basic. It can be delegated."

Stoner noted that a good many Air Force people who get into systems management use an electronics outlook that helps them think in terms of systems. But whether the best minds are in airframe or electronics firms, he said, is a moot question.

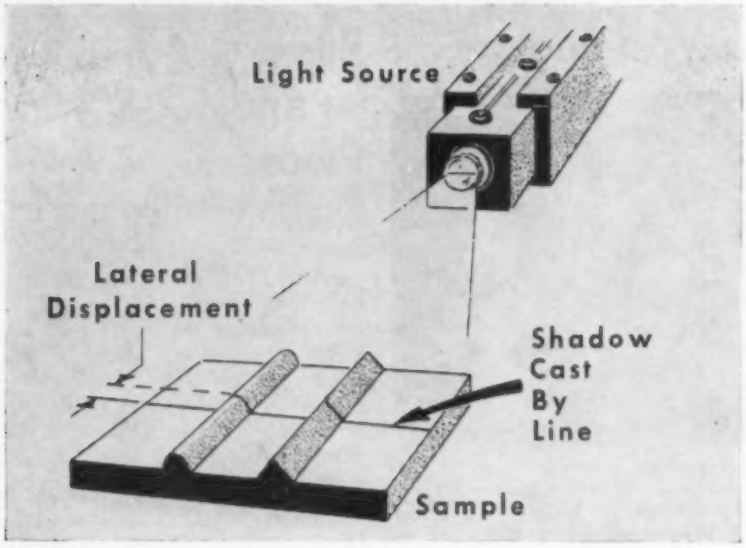
Philco–Oscar Simpson, manager of its western development lab, deplored management's tendency to think of itself as something abstract in order to avoid individual responsibility. Best output, he says, is achieved through management competence to make best use of technical abilities.

General Electric–A prime contractor, said Richard Shetler, manager of missile guidance for GE's defense electronics division, must have: centralized management control with simple command line and organizational stability, ability to handle project without interference from existing military or commercial programs, and demonstrated systems-management capability with understanding of systems concept. Shetler suggested that choice between a firm with electronics or airframe orientation depends on the technology that dominates the system.

Air Force–Col. Hall, panel moderator, declared that the Air Force–at least in some quarters–is veering from the weapon-management concept. Thor did not have a prime contractor, nor does an upcoming missile, the Minuteman. The Air Force, said Hall, drew up operational requirements for Thor, a small organization did the original design work, and then associate contractors for components were selected for major missiles.

He put the case against prime contractors this way. Whether handling electronics, airframe or engine, they favor design compromises most favorable to themselves. The Air Force lays out preliminary design according to what it expects the art to be able to deliver–not what industry is delivering at the preliminary design stage.

Hall said we are in the midst of a revolution–military, not industrial. The military is reorienting its people to see defense from a much broader view than someone in industry can have.



The shadow shows . . .
Here's how a hairline shadow from a separate light source is cast over surface specimen to reveal, through a microscope, irregularities of surface. Developed by GM Research Staff, the improved method uses light source separate from the microscope.

Improve Method of Measuring Surface Defects

DETROIT—An improvement in shadow casting—important in the study of crystal growth, corrosion and surface finish—has been reported by General Motors Research Staff. The new method reveals irregularities of surface as small as 0.0005 of an in. when viewed through a microscope.

The technique provides a separate light source with a horizontal hairline. When trained at an angle on the specimen, the hairline gives a shadow effect where surface irregularities occur, making measurement easier and more accurate. Previous techniques relied on light from the microscope.

Sharpness of line is obtained by standard optical means with a condenser. Displacement of the line depends on the angle of incidence. With the separate light source this angle can be selected at the best value.

Maser Does Electronic Job for Astronomy

ANN ARBOR, MICH.—A low-temperature ruby maser, said to outperform electron tubes and transistors, is taking on an assignment in astronomy. It is being incorporated in the 85-ft radiotelescope that the Univ. of Michigan is erecting at nearby Peach Mt.

The maser technique also promises greatly improved civil and military communications in the microwave frequency range of 1,000 to 20,000 megacycles; greater distance of television reception; and stronger signals from space vehicles. Efficiency of the technique comes from its harnessing the gyroscopic motion of electrons at temperatures near absolute zero to amplify extremely weak radio signals (*PE—Jan* 13, p. 10).

The radiotelescope application arises from the fact that the ruby maser can detect the tiny, natural radio emission from any object warmer than itself—therefore can discern radiation from cool bodies at short distances, or from stars thousands of light years away.

At the high operating temperatures of ordinary vacuum tubes, even at room temperatures with transistors, atomic motion produces radio noise. But in the ruby maser at a temperature of near absolute zero, this noise is almost silenced—making possible the amplification of extremely low-level signals.

University engineers place the ruby maser in a magnetic field and immerse it in liquid helium. The magnetic field aligns the electrons of the ruby's atom while the frigid helium reduces atomic noise. Electrical energy can trigger a large signal output.

Synthetic rubies are now available in production quantities at low cost and have extremely long life compared with other electronic components.

Listen Who's Talking—It's Production Machine

VAN NUYS, CALIF.—Production machines that "talk back" to man—and in his own language too—are making themselves heard in the expanding age of automation, according to Henry M. Lakin, a senior scientist at Lockheed's missile plant here, in describing the development of man-machine "common languages" at the second International Congress of Cybernetics in Namur, Belgium.

Any number of available statements, reflecting almost any situation the machine might encounter, can be set into the memory. Choice of the proper statement would depend on the situation the machine meets. The computer selects and prints out the phrase.

"And we aren't limited to polite conversation, either," Lakin said. The machine's back-talk could range from strictly-business phrases like "Have revised your last instruction" to "Let's not botch it up again, bud."

Develop Hydraulic Fenders for Ships

LONDON—An hydraulic fender to cushion a ship's impact on a pier has been designed by BP Tanker Co. to replace conventional rubber-backed wooden baulk. One or more liquid-filled cylinders are fixed horizontally to a frame below the pier's water line. The cylinders have a number of holes, fitted with pistons, for entry or escape of the liquid.

Ship's impact on the fender causes the pistons to displace oil in the cylinders while continued pressure causes some of the holes to be covered—increasing the fender's resistance. Actual fender consists of rotating barrel-shaped components—their axis vertically mounted in the frame. As the ship strikes the fender the components rotate to minimize the impact of the glancing blow.

Metal Foil Improves Welding

CINCINNATI—A welding process, developed in Germany, that feeds a metal foil strip between electrodes and the metal sheets being joined, is now available here through its licensee, Precision Welding and Flexopress Corp.

Designed to join sheets by resistance welding, the process eliminates conventional overlap and requires only 20% of the force needed for mash welding. The process also prolongs the life of electrodes substantially.

Called the Peco Foil Butt Seam Welding Process, it covers the joint with strips fed continuously from spools. The strips distribute welding current to both sheets and help reduce the rate at which heat is dissipated from the joint area. This produces a more uniform joint, free of checks or internal cracks.

Other advantages: smoother seams of high strength and density, higher welding speeds for the same amount of power, greater ease in cleaning the joint after welding.

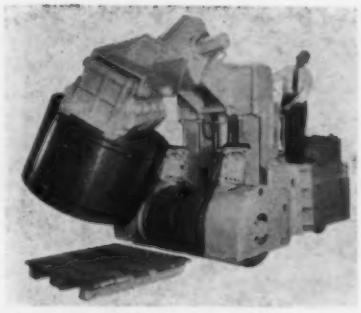
No overlap needed . . . when resistance welding is done this way and electrodes last longer. Foil strips fed into seam welder serve as bridge distributing current to both sheets at joint area.

Magnetics Assist in Fork Lift Trucking of 10-ton Tinplate Coils

CHICAGO—A magnetic attachment for electric fork lift trucks that facilitates moving of 10-ton tinplate coil through the entire strip steel mill production process has been developed by Automatic Transportation Co. Requiring no clamps, the new attachment called the Magnetic Coil Upender reduces the possibility of damage to a tinplate coil en transit.

Principal components mounted on a 45-degree rotator head are a rubber-cord load ram which projects from the center of a powerful electro-magnet. The rotator turns the coil to either vertical or horizontal position. Coils are lifted directly from the mandrel jacks located at the winding machines, and transported in horizontal position on the load-carrying ram to the palletizing and packaging area. Here the magnet is energized and the coil rotated 90 degrees to a vertical position, then placed on a pallet. The coil is wire-strapped to the pallet so that the magnetic attachment is able to lift the coil and pallet as one package.

Ram is locked in the horizontal position when carrying a load, and can be turned to vertical only when magnet is energized.



Magnetic coil upender . . . facilitates moving of tinplate coils up to 10-tons through entire production process in strip mills.

Correction

In "How to Figure Deflections of Elastically Supported Cantilever Beams," Aug. 4 issue, we unfortunately substituted *b* for *l* in several places. In the formulas on page 63, we were at least consistent about it—and suggest that readers change *b* to *l* wherever *b* occurs on that page of their copy. On page 64, it will be more evident that in Cases 3, 5 and 7, "$b = b$" should read "$b = l$."

Bits and Pieces

A concentrated anti-submarine research program . . . is being initiated at Chance Vought Aircraft with a complement of 50 engineers, who will concentrate on seven fields: analysis of systems leading to new devices, vehicles and equipment; search for new sub-detecting principles; design of anti-submissiles and the systems for using them; improved types of aircraft; R&D geared to developing detecting devices; nuclear propulsion and its adaptation to anti-sub warfare; and military liaison.

Catalogue index analyzer . . . will be produced by IBM's Special Engineering Products Div. for DuPont. The machine will provide fast automatic reference to cataloged data. It is based on a system of continuous, automatic multiple comparison developed by Documentation, Inc., Washington.

Japanese government has approved license agreement . . . between Douglas Aircraft Co. (Japan) Ltd. and the Hokkaido government for production of aircomb, a honeycomb core structure of paper impregnated with phenolic resin for use with such face materials as aluminum, plywood, stainless steel, magnesium and porcelain-enameled steel.

Recent growth of American Rocket Society . . . has influenced decision of the Society and the American Society of Mechanical Engineers to conduct annual meetings separately. The two organizations' members will continue to enjoy reciprocal privileges.

Value engineering . . . involving a look-see at vital defense projects after they're 75% completed has saved more than $400,000 since Aug., 1957 at RCA's Defense Electronic Products. Introduced by the US Navy's Bureau of Ships after World War II, value engineering requires engineers with a broad background in design, materials, cost and combine vision with diplomacy. According to RCA officials, in one instance $95,000 was saved in radar manufacture by eliminating unnecessary cable connections and simplifying maintenance.

Navy Develops Propeller for Super-speed Craft

WASHINGTON—A super-cavitating propeller equipped with knife-edge blades curved to eliminate the vapor pocket drag of a conventional propeller has been developed by the Navy Bureau of Ships. Result: underwater and hydrofoil craft may soon be propelled at a speed up to 200 knots, while more conventional craft may be pushed to 70 knots. Also, collapse of vapor bubbles beyond the trailing edge may reduce cavitation erosion.

Up to now, low propeller efficiency has limited Navy engineers seeking to design superspeed craft. Main problem has been cavitation—the formation of a vacuum or vapor pocket that streams behind the propeller. The faster the propeller turned, the larger the vapor pocket; the latter creating a propeller drag, reducing propeller efficiency.

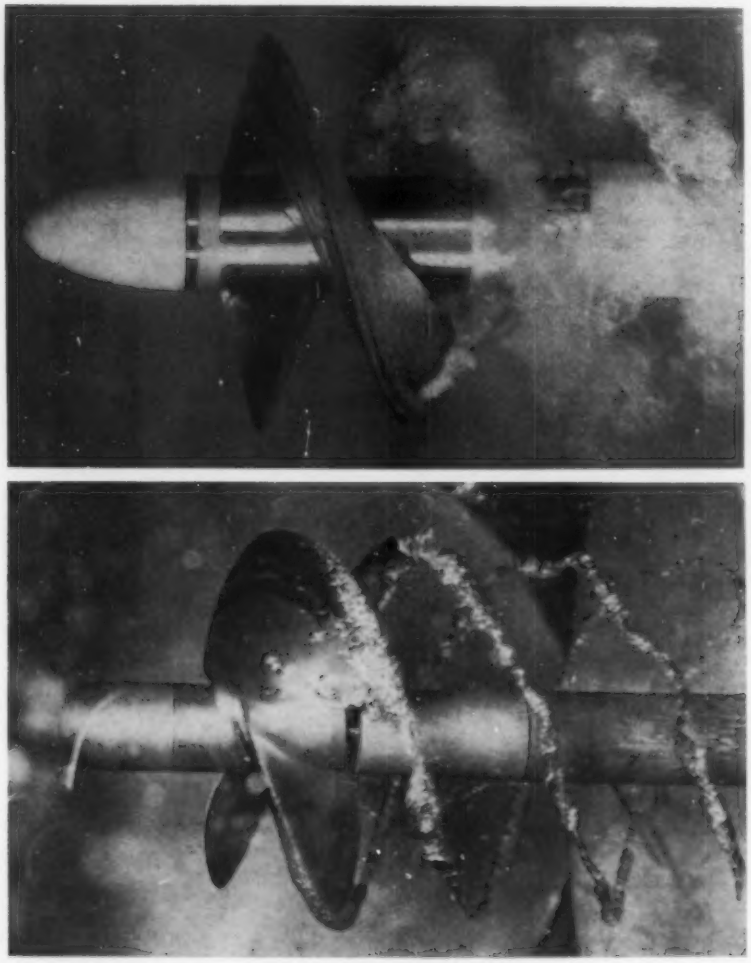
The new design spreads the vacuum evenly over the blade surface and sloughs it off the knife-like edge more smoothly. This minimizes — but doesn't completely eliminate — the harmful drag. The blades of the new propeller are wider at the hub than a conventional propeller and taper more to a point. Tests have been made on 2, 3 and 4 blade propellers.

The new propeller will require new hull designs that can withstand pressures resulting from super speeds. Also, it may call for bulges rather than the sleek lines of today's craft—guided by principles similar to those that produced the area rule design in aircraft.

Sea-going engines available to the Navy that can produce the needed power to push the vessels at super speeds include the new gas turbine. Right now, gas turbines produce from 6000 to 10,000 rpm but because of low propeller efficiency have been geared down to 400 rpm. With new propeller, full power of these engines can be utilized. Although some conversion may be done, generally the Navy expects to use the new propellers on new ships—designed from scratch to take the new speed. One of the first uses will likely come in its hydrofoil boat program. Navy has been testing hydrofoils—where the boat rides on a water ski arrangement—for some time, and thinks the boats have value for such things as high-speed submarine chasers. Another immediate use for the propellers is on submarines, the Navy says.

Nuclear power and new designs have made it possible to push subs under the water at high speeds already. Use of the propeller would increase these speeds—estimated at around 40 knots now. But there is also a limitation involved, as far as subs are concerned. The new propellers are extremely noisy. So it would only be in special cases such as radar picket subs like the new Triton and the polaris launching submarines that the new propellers would likely be used on. With these speeds, stealth is not as important as moving the vessel quickly to new strategic locations.

The same hydrodynamic principle, Navy says, can be adapted to seaplanes using hydrofoils. They say it may bring this type of plane back into wide use for the Navy. The reason is that the same cavitation effect that is a drag on propellers has limited the use of hydrofoils as a means to get planes airborne. The Navy is experimenting with new hydrofoil designs to lift seaplanes enough off the water to give them the speed they need for take-off. Designers say the principle of the super-cavitated propeller can be applied to seaplanes successfully.



Cavitation and supercavitation . . .
New propeller, top, with supercavitation (SC) and conventional propeller, below. Work at David Taylor Model Basin showed that SC propellers should be restricted to high speeds (above 50 knots) but may be used at lower speeds using ventilated sections.

Vanguard Launching Troubles Denied

NEW YORK—Publication of an item concerning the Navy's Vanguard program appearing on Page 6 of the Aug. 25 edition of PRODUCT ENGINEERING provoked the following comments from Walter Kauders of Loewy-Hydropress, builder of the Vanguard launch stand (*PE, p 84, Sept. 30, '57*).

"The last paragraph of your interesting item, 'A Small Navy Satellite,' contains a statement on the Vanguard launch installation which is incorrect. It says, 'All failures to date have come in the first stage rocket. Part of the Vanguard's troubles come from the launch stand, Navy thinks. And it has to build a new one.'

"No part of the Vanguard troubles came from the launch stand," Kauders writes. "All Vanguard rockets rose from the launch stand. The mishaps occurred after the Vanguards had detached themselves, clear of stand.

"The reason why the Navy has ordered a partial revision of the stand is that specifications were changed and called for operation under different conditions. It may be worthwhile to mention that the present launching facility retained almost the complete original installation including its electronic instrumentation. The quality of our installation was demonstrated during the Vanguard misfiring Dec. 6, 1957, when the rocket exploded, spewing almost 10 tons of boiling liquids over the entire launching facility. Our automatic fire fighting system released a torrent of water fog and minimized the destruction to minor damages that could be repaired so quickly that the system was operational a week later."

A PRODUCT ENGINEERING re-check of the facts shows all failures in the Vanguard have not come in the first-stage rocket. Rather, Navy attributes most of the failures to other rocket stages and phases of the orbital attempts. As for the statement that "part of the Vanguard troubles come from the launch stand, Navy thinks," there is no official word on this from the Navy. Navy officials contacted will not say for the record that they found specific troubles in the previous launch stand. They say only that they "have found a chance to improve it," as the basic reason for building a new one.

COMING EVENTS

15-17 . . . . American Institute of Electrical Engineers, International Conference on Computer Applications in the Power Industry. Sessions also will include the design of rotating and non-rotating machinery, King Edward Sheraton Hotel, Toronto, Canada.

15-18 . . . . American Rocket Society, 1958 Annual Meeting, Hotel Statler, Detroit, Mich.

15-19 . . . . Instrument Society of America, 13th Annual Instrument-Automation Conference and Exhibit, Philadelphia, Penna.

22-24 . . . . Standards Engineers Society, 7th Annual Meeting, Benjamin Franklin Hotel, Philadelphia, Penna.

23-26 . . . . Association of Iron and Steel Engineers, 1958 Iron and Steel Exposition and Convention, Cleveland Auditorium, Cleveland, Ohio.

24-25 . . . . Institute of Radio Engineers, 7th Annual Symposium on Industrial Electronics, Rackham Memorial Auditorium, Detroit, Mich.

24-26 . . . . American Society for Testing Materials, Mass Spectrometry Panel of the Hydrocarbon Research Group, British Institute of Petroleum, Joint Meeting, University of London.

24-25 . . . . Institute of Radio Engineers, American Institute of Electrical Engineers, 7th Annual Conference on Industrial Electronics, Rackham Memorial Building, Detroit, Mich.

25-27 . . . . Porcelain Enamel Institute, Annual Meeting, The Greenbrier, White Sulphur Springs, Va.

28-Oct 1 . . . . American Society of Mechanical Engineers, Power Div, Conf., Hotel Statler, Boston, Mass.

28-Oct 2 . . . . Pressed Metal Institute, Annual Meeting, The Cloisters, Sea Island, Ga.

29-Oct 4 . . . . Society of Automotive Engineers, National Aeronautical Meeting, Aeronautic Production Forum and Aircraft Engineering Display, The Ambassador, Los Angeles.

28-Oct. 2 . . . . Pressed Metal Institute, Annual Meeting, Sea Island, Ga.

This Tractor Steers Itself

BIRMINGHAM, MICH. — Automatic steering of tractors for cultivating such row crops as corn and cotton was demonstrated by Ford Motor Co.'s Tractor and Implement Division at the Farm Machinery Research and Engineering Center here.

A pivoted feeler, roughly hairpin-shaped, touches each plant in succession. When a plant is out of line with the others, a movement of the "feeler" actuates snap-action switches to supply power to a small servomotor in the tractor's power steering linkage. The linkage is lengthened or shortened as necessary to steer the tractor correctly so the cultivator is centered when it passes the plant.

The tractor operator can override the control at any time, but need never touch the steering wheel while the tractor is going down the crop row, and speed of cultivation is faster than with manual control. The device will be available in time for next year's cultivating season.

Design Better Hi-Temp Coils for Electronics

SAN LEANDRO, CALIF.—High temperature coils, capable of withstanding extreme vibration, physical and thermal shock have been developed by Otto N. Bloom, of the Tur-bo Jet Products Co.

A proprietary potting compound gives physical support to the windings to protect them against damage from shock or vibration, and also is absorbed into the spaces between the wires of tightly-wound coils to fill any breaks in the insulation that may have occurred during the winding. During a recent 4-day experiment Bloom kept a coil in an oven at temperatures ranging from 1000° F to 1550° F while running continuous tests to show whether any breakdown of insulation had taken place. Previous to this, the test coil had been vibrated at varying frequencies and G-loadings. Further experiments are now in progress to determine the precise point at which the insulation will fail.

HAS GLASSY LOOK

The potting compound, Tur-bo Jet's own development, presents a glassy appearance. This is poured in place while in a free-running condition, at which time it is probably free-running enough to be drawn into the coil structure by capillary action.

DU PONT

LUCITE® ACRYLIC RESIN

PRODUCT ENGINEERING NEWS

New 8-mm. Electric Eye movie camera features photoelectric cell molded of Du Pont LUCITE®

Electricity produced by light alone on the photoelectric cell made of LUCITE acrylic resin controls the iris mechanism of Bell & Howell's new 8-mm. Electric Eye movie camera. LUCITE was specified because of its outstanding properties—its optical accuracy, lightness in weight and adaptability to intricate configuration. It transmits about 92% of light striking it and is exceptionally strong and durable. Its shatter resistance facilitates handling and helps eliminate breakage. Moreover, LUCITE does not become discolored or cloudy with age. (Molded for Bell & Howell, Chicago, Ill., by Pereles Brothers, Inc., Milwaukee, Wis.)

MOTOROLA TRADEMARK on two-way radio remote-control consolette is molded of red LUCITE acrylic resin and back-painted in white. Left edge of trademark is unpainted, which permits light to shine through during transmission, indicating that unit is "on." Cover for clock section is molded of transparent LUCITE for crystal-clear visibility. Consolette features provisions for 13 controls on front panels. (Molded for Motorola Communications and Electronics, Inc., Chicago, Ill., by Romar Plastics, St. Charles, Ill.)

ATTRACTIVE TRACTOR EMBLEM of LUCITE is back-painted in platinum and gold shades for a three-dimensional effect. Visible for great distances, its sparkling beauty is unaffected by age, sunlight or moisture. (Molded for J. I. Case Company, Racine, Wis., by Mimosa Corp., Belton, S. C.)

• • •

To find out how LUCITE acrylic resin can help you in your designs, write to: E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Department, Room 36-9-15, Wilmington 98, Delaware. In Canada: DuPont Company of Canada (1956) Limited, P.O. Box 660, Montreal, Quebec.

OVER

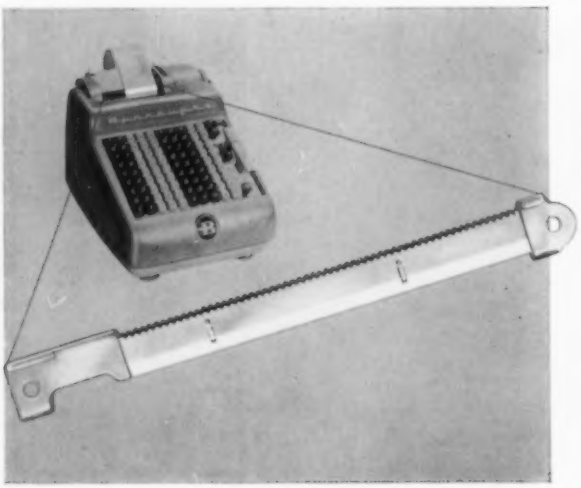
DU PONT

LUCITE®
ACRYLIC RESIN

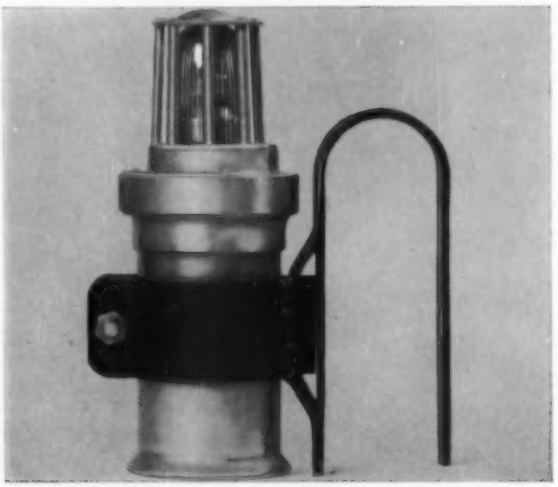
NEWS

Medallion on power lawn mower molded of LUCITE® for lasting beauty and outstanding weather resistance

Lawn-mower medallion of LUCITE acrylic resin is extraordinarily strong and weather-resistant. Because of the nonyellowing characteristics of LUCITE, its color and clarity will last through years of outdoor exposure. LUCITE is available in a broad selection of transparent, translucent and opaque colors, and can be molded easily and economically in sizes and shapes to meet many needs. One of the newest formulations permits molding temperatures 30° F. to 50° F. higher than previous compositions, with increased fluidity during processing and improved stability afterwards. (Molded for Aircapitol Manufacturers Inc., Wichita, Kansas, by Midwest Plastics Corporation, Wichita.)



TEAR-OFF TAB of LUCITE on Burroughs' full-keyboard Director adding machine has transparent, tough molded teeth to facilitate tearing off sections of the tabulating tape. Tab also presents an unobstructed view of work in the machine. (Molded by the Plymouth Manufacturing Division of Burroughs Corporation.)

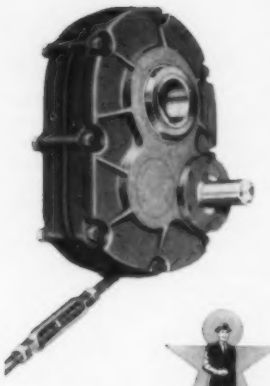


TRANSLUCENT RED DOME of mine-car safety lamp is made of shatter-resistant LUCITE. Does not become discolored or cloudy with age. Approved by the U.S. Bureau of Mines, the lamp stands up under roughest usage. (Dome molded for Concordia Electric Company, Pittsburgh, Pa., by Parker Plastics Corp., Pittsburgh.)

Perhaps LUCITE acrylic resin is the answer to your design problems. For more information, write to: E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Department, Room 36-9-15, Wilmington 98, Delaware. In Canada: Du Pont Company of Canada (1956) Limited, P. O. Box 660, Montreal, Quebec.

THERE'S QUALITY IN TORQUE-ARM

...AMERICA'S MOST WIDELY USED SHAFT-MOUNTED SPEED REDUCER



Extreme ruggedness and top quality are built into every detail of the Dodge Torque-Arm Speed Reducer—from the specially heat treated helical steel gears to the corrosion resistant semisteel housing. Broad demand has made it necessary to add sizes until today Torque-Arm is America's most complete (and most widely used) line of shaft-mounted speed reducers. Capacities range from 1 to 100 hp; output speeds from 12 to 378 rpm.

Torque-Arm is mounted on the driven shaft, in any vertical or horizontal position. It is anchored by the torque-arm fastened to any fixed object. No need for foundation, flexible coupling, sliding base. No lining up difficulties. The unit is driven through any V-belt drive. Savings up to 1/3 are possible and Torque-Arm's efficiency is high. It delivers 97% efficiency in double reduction models; and almost 99% in single!

Ask you local Dodge Distributor — or write us for bulletin.

DODGE MANUFACTURING CORPORATION
1200 Union Street, Mishawaka, Indiana

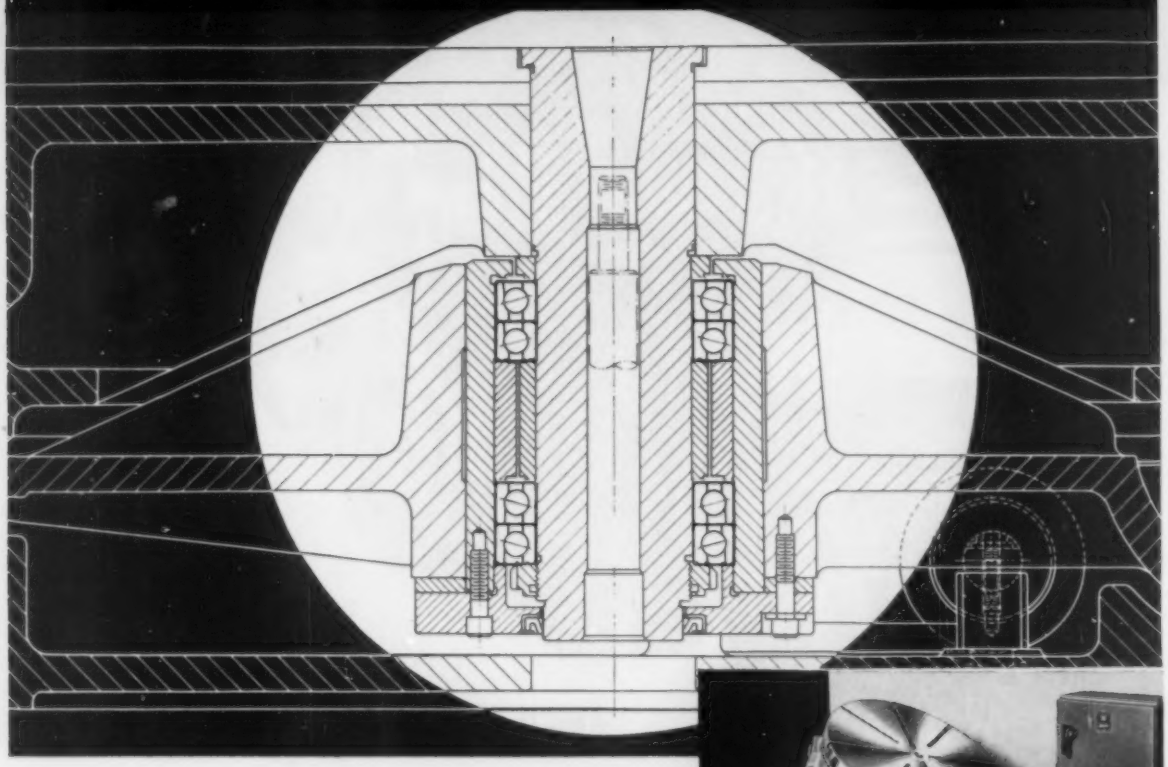
CALL THE TRANSMISSIONEER — your local Dodge Distributor. Factory trained by Dodge, he can give you valuable help on new, cost-saving methods. Look in the white pages of your telephone directory for "Dodge Transmissioneer."

DODGE
of Mishawaka, Ind.

←CIRCLE 132 READER SERVICE CARD

CIRCLE 133 READER SERVICE CARD

1½-ton rotary table held accurate to seconds of arc!



PRATT & WHITNEY
equips for precision with
FAFNIR BALL BEARINGS

The extreme accuracy designed into Pratt & Whitney's 36" Tilting Rotary Table puts a heavy premium on bearing performance. For the critical central pivot application, Fafnir super-precision ball bearings are specified.

Here are bearings with the capacity and rigidity to hold a ton-and-a-half table at *seconds of arc* accuracy — and maintain this precision under large-job work loads.

It takes plenty of bearing to deliver performance like that! Yet the application is typical of many in Fafnir's files. Fafnir's "experience in precision" can help *you* solve a bearing problem. Write The Fafnir Bearing Company, New Britain, Connecticut.

FAFNIR
BALL BEARINGS
MOST COMPLETE LINE IN AMERICA

Pratt & Whitney 36" Precision Tilting Rotary Table is designed for large jobs requiring precise circular spacing and angular positioning. It is completely powered . . . makes possible several machining or inspection operations with a single setup . . . permits direct rotary vernier readings to two seconds of arc over a 360° range and tilting vernier readings to one minute of arc over a 90° range, with a sine bar arrangement for setting table tilt accurately to seconds.

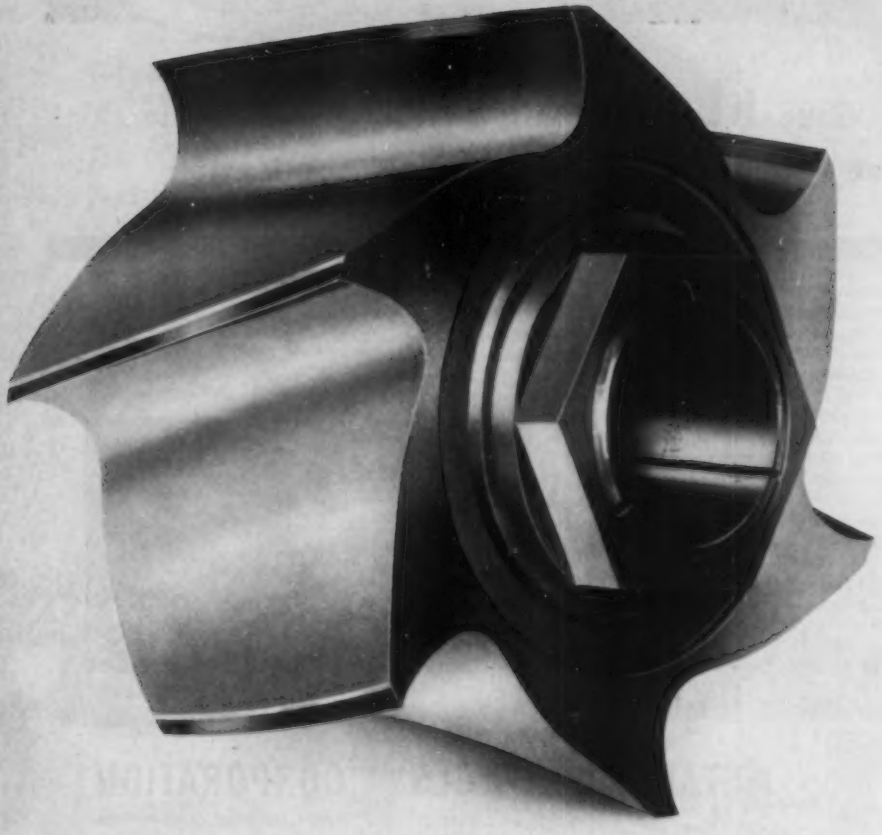
Fafnir Super-Precision Ball Bearings, counterbore construction, support the central pivot of the table component in Pratt & Whitney's 36" Tilting Rotary Table. Mounted in tandem duplex pairs, they provide the exceptional rigidity necessary for this precision application.

NOW: Higher strength costs you less! Specify TENZALOY*, the self-aging aluminum alloy that needs no heat treatment! TENZALOY is a corrosion resistant aluminum alloy that ages at room temperatures, gives high strength properties superior to those normally obtained only by solution treating, quenching and artificial aging. And these properties are stable, proved by conclusive test data taken over a ten year period. No special foundry techniques are required. No fluxes. Castability is excellent with sand cast and plaster molds, and many permanent molds. TENZALOY will not "grow". It takes a brilliant polish and anodizes clear white. Write for TENZALOY Bulletin No. 103 or call one of Federated's 22 sales offices. Federated Metals Division, 120 Broadway, New York 5. In Canada: Federated Metals Canada, Ltd., Toronto and Montreal.

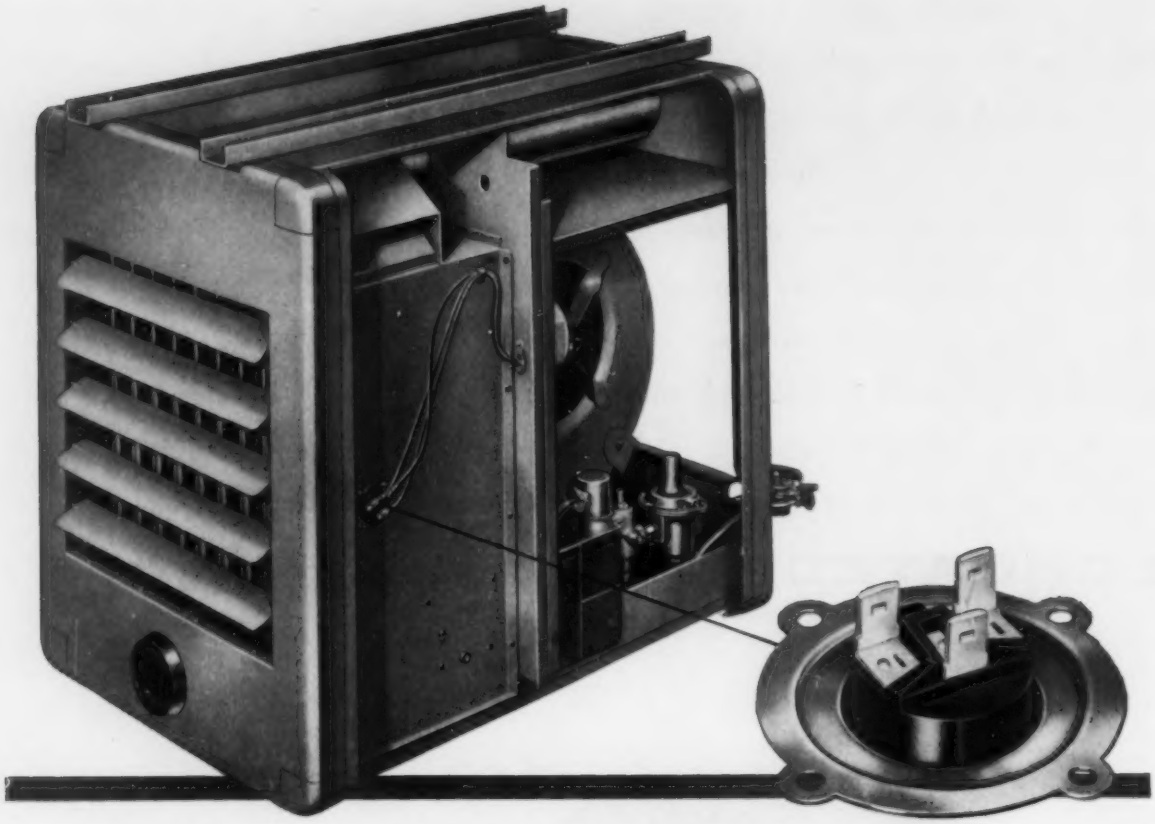
FEDERATED METALS DIVISION OF

ASARCO

AMERICAN SMELTING AND REFINING COMPANY



**TENZALOY is one of a complete range of Federated aluminum casting alloys. These and hundreds of other quality controlled non-ferrous metal products are produced in the 11 plants of the Federated Metals Division.*



Modine chooses **KLIXON** Snap-Acting Thermostat

for Low Cost • Inherent Safety • Ease of Application

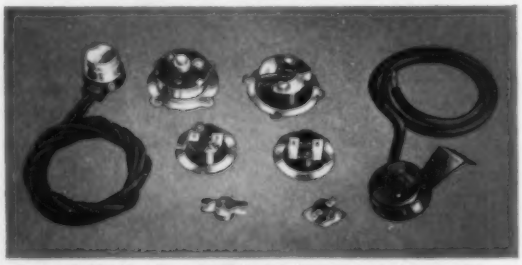
"The KLIXON *fixed-temperature, snap-acting thermostat was selected for our new Modine blower type gas fired unit heater on the basis of low cost, inherent safety and ease of application to our unit."*

That's how the Modine Manufacturing Company, one of the nation's foremost makers of gas heating equipment, feels about KLIXON Thermostats. And, Modine goes on to say:

"As an important component in the control system, we are sure that the KLIXON *Thermostat helps us provide 100% safety in our unit."*

Today hundreds of leading original equipment manufacturers specify and use KLIXON Controls. These controls are available in both sealed and open construction in a wide variety of types and sizes. Fixed temperature settings are custom calibrated at the factory to meet the customer's requirements.

Competent Spencer Division engineers at the factory and in the field will gladly help you make test applications of KLIXON Controls. Send for free literature on the KLIXON line now and get acquainted with the application possibilities on your equipment.



Typical KLIXON Fixed Temperature Controls for many types of home appliances.

METALS & CONTROLS CORPORATION

Spencer Division 3809 Forest Street, Attleboro, Mass.

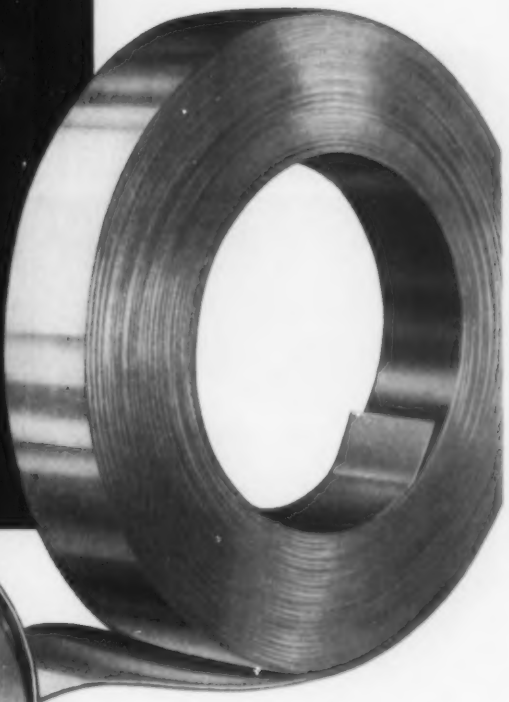
KLIXON®

TWO METALS ARE OFTEN BETTER THAN ONE

General Plate

CLAD PLATINUM-GROUP METALS

Greatly reduce material costs . . .



Give You These Additional Advantages

- **Greater Strength**
- **Substantial Savings in Weight**
- **Controlled Electrical and Physical Properties**
- **Made without Intermediate Bonding Agents or Diffusion Techniques, by General Plate's Exclusive PT Bonding Process.***

* U. S. PATENTS 2,691,815 — 2,753,623

General Plate Clad Platinum-Group Metals open up many new applications in which solid platinum-group metals could never be used because of the very high cost.

Typical applications where clad platinum-group metals reduce costs include: electrodes, electrical contacts, anodes and cathodes, slip rings, laboratory ware, rupture diaphragms, and jewelry.

Whatever your platinum needs, it will pay you to investigate General Plate's platinum-clad metals first — they're available in sheet, wire, tubing, foil and gauze.

In addition, General Plate Division has complete fabricating facilities with which to blank, form, spin, draw, and machine clad platinum parts, and produce welded or brazed assemblies.

General Plate also has modern assaying and refining facilities which include complete equipment for the recovery of platinum and platinum-group metals.

Write today for information on General Plate platinum-clad metals — ask for catalog sheet PLA-5.

SINGLE CLAD

DOUBLE CLAD STRIP

OVERLAY

WIRE

TUBING

You can profit by using General Plate Clad Platinum-Group Metals

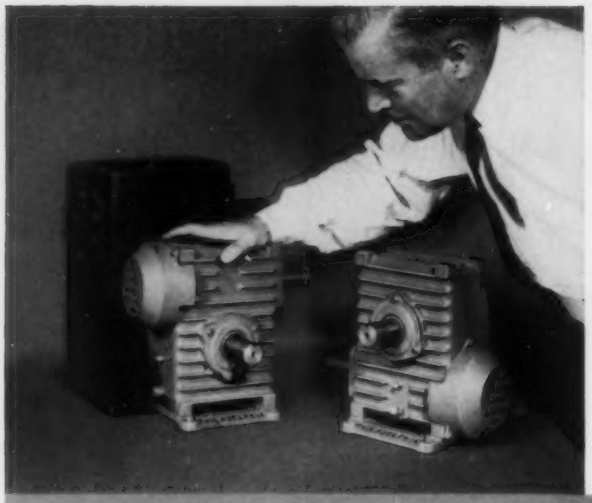
METALS & CONTROLS CORPORATION

General Plate Division

1009 Forest Street, Attleboro, Mass.

FIELD OFFICES: NEW YORK • CHICAGO • DETROIT • INDIANAPOLIS • MILWAUKEE • PASADENA

new high capacity fan cooled reducers take up 50% less space



LOOK AT THE SPACE YOU SAVE!

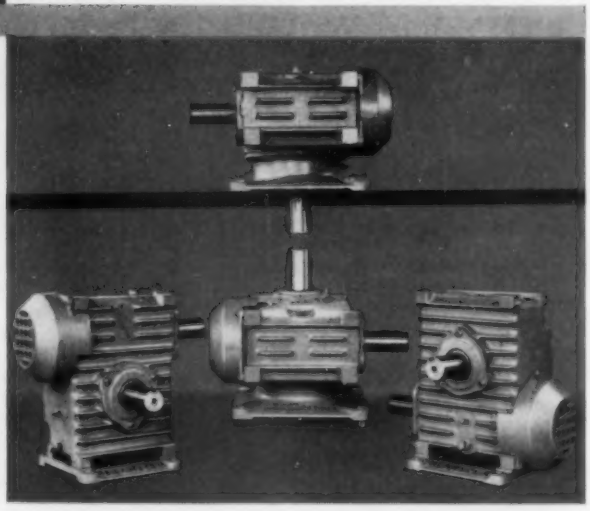
Think what this can mean to your products! You can make important savings in space and weight . . . in the neighborhood of 50% . . . depending upon output torque requirements. Or, you can design for heavier loads . . . up to 80% . . . without adding an ounce of weight to your product. You get more horsepower per dollar!

This new line of Philadelphia Fan cooled Worm Gear Reducers is available in 3, 3½ and 4″ center distances for ratios from 5 1/6:1 to 60:1. Fan cooling, sturdy finned housings, improved tooth forms, precision ground alloy steel worms and special high strength bronze gears all combine to give you a drive that will handle heavier loads in less space.

STANDARD STOCK PARTS SIMPLIFY SELECTION.

These new fan cooled units have a degree of simplicity and flexibility never before available. Standardized housings, fans, gearing and mounting bases permit you to select any drive arrangement you need . . . permit us to give you prompt delivery from stock.

They simplify your design problems too. For Example: horizontal units can be furnished without mounting bases. Housings can be designed as an integral part of your product.



For more information . . . horsepower ratings . . . dimensions . . . construction details . . . write for your copy of Bulletin WG-583.

PHILADELPHIA GEAR CORPORATION

Erie Avenue and G Street • Philadelphia 34, Pennsylvania

philadelphia gear drives

Offices in all Principal Cities • Virginia Gear & Machine Corp., Lynchburg, Va.

INDUSTRIAL GEARS & SPEED REDUCERS • LIMITORQUE VALVE CONTROLS • FLUID MIXERS • FLEXIBLE COUPLINGS

NOW!

FIVE MOLY CARBURIZING STEELS ACCEPTED AS STANDARD AISI-SAE GRADES

AISI Number	C	Mn	P Max.	S Max.	Si	Ni	Cr	Mo	Corresponding SAE Number
4422	0.20/0.25	0.70/0.90	0.040	0.040	0.20/0.35	—	—	0.35/0.45	4422
4427	0.24/0.29	0.70/0.90	0.040	0.040	0.20/0.35	—	—	0.35/0.45	4427
4520	0.18/0.23	0.45/0.65	0.040	0.040	0.20/0.35	—	—	0.45/0.60	4520
4718	0.16/0.21	0.70/0.90	0.040	0.040	0.20/0.35	0.90/1.20	0.35/0.55	0.30/0.40	4718
8822	0.20/0.25	0.75/1.00	0.040	0.040	0.20/0.35	0.40/0.70	0.40/0.60	0.30/0.40	8822

Wide use in automotive transmission and differential ring gears and pinions results in recognition of Molybdenum's economical contribution to case and core hardening in carburizing steels. These economies can be useful in most of your carburizing applications. Now available through your steel suppliers.

CLIMAX MOLYBDENUM CO.

A DIVISION OF AMERICAN METAL CLIMAX, INC. • 500 FIFTH AVENUE, NEW YORK 36, N. Y.

Enlarged 75 times, screw-machined aluminum bushing shows finer precision than the grooves of the LP record on which it rests.

What the designer conceives . . . aluminum achieves!

0.040-INCH DIAMETER ALUMINUM BUSHING TO HOLD L-P RECORD PLAYER NEEDLE

Designers: Fidelitone, Inc.; Jensen Industries
Screw Machine Operator: Walter Precision Company

The sensitive diamond or sapphire needle used in modern L-P record players must be held by a precision bushing that is soft, but at the same time very strong.

SOFT—to permit the needle to be inserted by gentle pressure.

STRONG—to hold the needle firmly in precise alignment through years of use. In addition, the holding piece must be non-magnetic and light weight.

To best fit these conditions of the bushing design, aluminum was selected. But because the smallest readily-available aluminum rod was ⅛-inch size, they still had the problem of grinding down to a center size of 0.045 before manufacturing the bushing.

Their solution? . . . call Kaiser Aluminum screw machine design and operator specialists. Kaiser Aluminum, besides drawing the rod to 0.045, also *straightened* the coiled aluminum into 10-foot rods.

This material was held to a plus or minus .0005 inch, making it possible to maintain concentricity and finish the part to these dimensions: Diameter 0.040; Overall Length 0.050 to 0.055; Inside Hole Diameters 0.0145 and 0.0165. The smallest O.D. is 0.027 to 0.028, making a wall thickness of only 0.0065.

The manufacturer now gets four times as many parts from the same amount of metal—about 36,000 parts per pound—at half the former cost!

Kaiser Aluminum specialists are immediately available to offer design and production assistance for *any* screw machine problem that you may have. Call the Kaiser Aluminum sales office or distributor listed in your telephone directory.

Kaiser Aluminum & Chemical Sales, Inc., *General Sales Office*, Palmolive Bldg., Chicago 11, Ill.; *Executive Office*, Kaiser Bldg., Oakland 12, Calif.

FOR THE COMPETITIVE EDGE, GO ALUMINUM

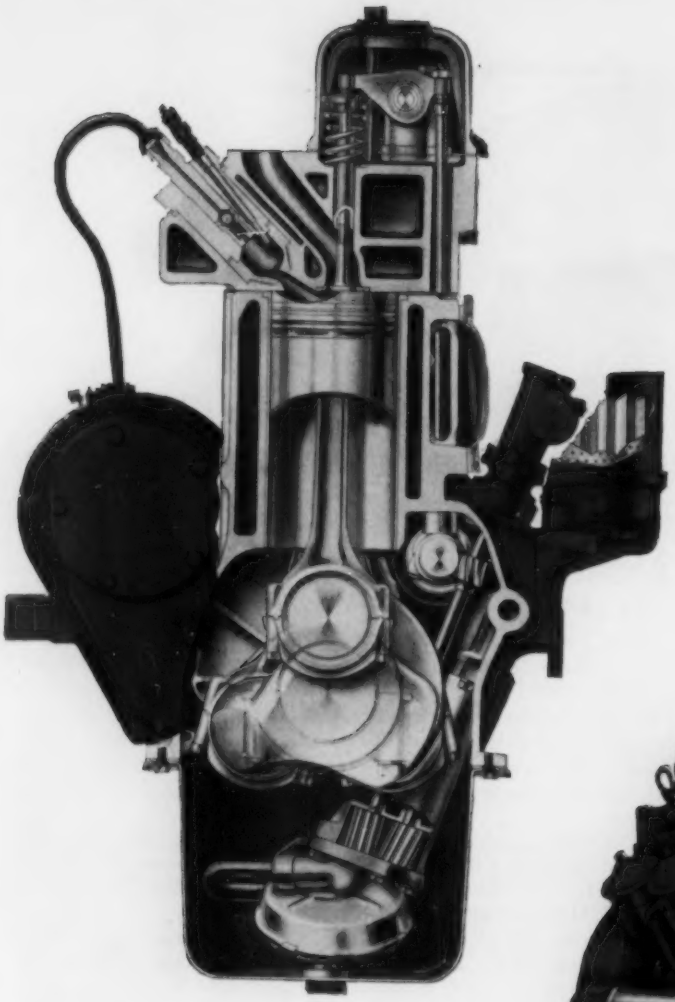
KAISER ALUMINUM

SEE "MAVERICK" • SUNDAY EVENINGS, ABC-TV NETWORK • CONSULT YOUR LOCAL TV LISTING

FOUR six cyl. DIESEL OR

Now you can put a power plus in your products with four new International 6-cylinder 75 or 90 horsepower engines. Each new pair of diesel or carbureted engines is interchangeable in power and dimensions. And because all four are specifically built for heavy-duty work, many parts are common.

The 90 hp pair, the new UD-282



New 6-cyl. diesel front section and right side view of complete 6-cyl. engine.

UD-236. .75 max. hp @ 2400 rpm
UD-282. .90 max. hp @ 2400 rpm

HEAVY-DUTY ENGINE FEATURES FOR DEPENDABLE, LOW-COST PERFORMANCE

UD-236 and UD-282 Diesel Engines

- 17.6:1 compression ratio for compression ignition and minimum fuel consumption
- Simple accessible fuel injection system with automatic advance for best fuel economy
- Precombustion chambers for low firing pressures and clean burning of No. 2 diesel fuel under all loads and speeds
- Exhaust valve rotators and intake valve umbrella oil seals
- Easy 12-volt direct electric starting
- Pressure lubrication through full-flow filter and rifle drilled passages
- Deep I-block crankcase ribbed for extra strength and rigidity.
- Replaceable cylinder sleeves for low cost life extension
- Heat treated forged steel I-beam connecting rods
- Low friction aluminum-alloy dished top pistons
- Thoroughly sealed against life-robbing dust and dirt
- 6-cylinder smoothness in a complete package

UC-221 and UC-263 Carbureted Engines

- 7.2:1 compression ratio and large 18 mm spark plugs for top performance on regular gasoline
- Updraft carburetor and top outlet exhaust for high sustained power output with minimum heat interference
- Fully machined combustion chambers for uniform power from each of six cylinders
- Exhaust valve rotators and intake valve O-ring oil deflectors
- 12-volt starting and ignition system
- Pressure lubrication through full-flow filter and rifle drilled passages
- Deep I-block crankcase ribbed for extra strength and rigidity
- Replaceable cylinder sleeves for low cost life extension
- Heat treated forged steel I-beam connecting rods
- Low friction aluminum-alloy stepped-dome pistons
- Thoroughly sealed against life-robbing dust and dirt
- 6-cylinder smoothness in a complete package

NEW International 75-90 horsepower

GASOLINE INTERCHANGEABLE ENGINES

and UC-263, as well as the 75 hp UD-236 and UC-221, feature efficient, economical valve-in-head design, replaceable cylinder sleeves, thru-hardened counterbalanced crankshafts and gear-driven induction hardened camshafts for a new high in long life dependability.

The UD-282 and UD-236 are direct-start diesels with time-proven International pre-combustion chamber design. Use of a ¼" larger bore in the diesels makes possible the same power as corresponding gasoline models with lower B.M.E.P. A glow plug for each pre-cup is regular equipment for easy starting in any weather.

Gear-driven mechanical governors on all engines provide excellent speed regulation. Rated load speeds to 2400 rpm are available to suit application requirements.

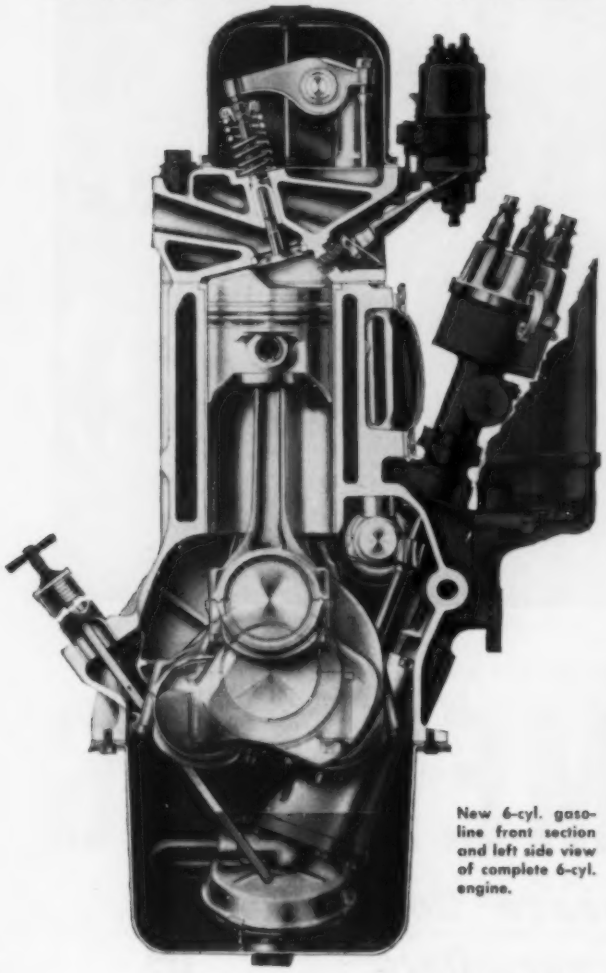
Installation in your products is simplified by six-cylinder built-in smoothness and availability of matched power unit components including air cleaner, base, radiator and enclosure.

For complete information on any of 22 International 4, 6, and V-8 engines, write International Construction Equipment Division, Melrose Park, Illinois.

Brief Specifications

MODEL	UC-221	UD-236	UC-263	UD-282
Bore	3⅞"	3 11/16"	3⅞"	3 11/16"
Stroke	3 11/16"	3 11/16"	4.390"	4.390"
Displ. cu. in.	221	236	263	282
Max. hp @ 2400 rpm	75	75	90	90
@ 1800 rpm	61	61	72	72

Overall length of all engines with fan and No. 3 flywheel housing is 41⅜"



New 6-cyl. gasoline front section and left side view of complete 6-cyl. engine.

International® *Construction Equipment*

International Harvester Co., 180 N. Michigan Avenue, Chicago 1, Illinois

A COMPLETE POWER PACKAGE: Crawler and Wheel Tractors . . . Self-Propelled Scrapers . . . Crawler and Rubber-Tired Loaders . . . Off-Highway Haulers . . . Diesel and Carbureted Engines . . . Motor Trucks . . . Farm Tractors and Equipment.

UC-221..75 max. hp @ 2400 rpm
UC-263..90 max. hp @ 2400 rpm

CIRCLE 143 READER SERVICE CARD

Splices support All-Pro Tackle Lou Groza

The four corner splices in this extruded rubber windshield weather-strip produced by Ohio Rubber are strong enough to fully support 252-lb. All-Professional League Tackle Lou Groza of the Cleveland Browns, plus all his football gear.

Each of the four splices is a corner molded into an extruded weather-strip for perfect fit without tension. Neatness of splice, as well as strength, is an important factor because of the weather-strip's ultimate use in an automobile windshield assembly.

This ability to incorporate desired strength as well as neat appearance into splices is typical of ORCO's "customeering" of parts made from rubber, synthetic rubber, silicone rubber, polyurethane and flexible vinyl, whether they be molded, extruded or bonded to metal or other material.

ORCO's integrated research, design, electronically controlled mixing and production facilities assure component uniformity and quality to meet the most exacting requirements. Why not check with ORCO engineers on your very next rubber or vinyl component problem and see for yourself how ORCO CUSTOMEERING can work to your greater advantage.

Send for free booklet "Component CUSTOMEERING rubber and vinyl parts".

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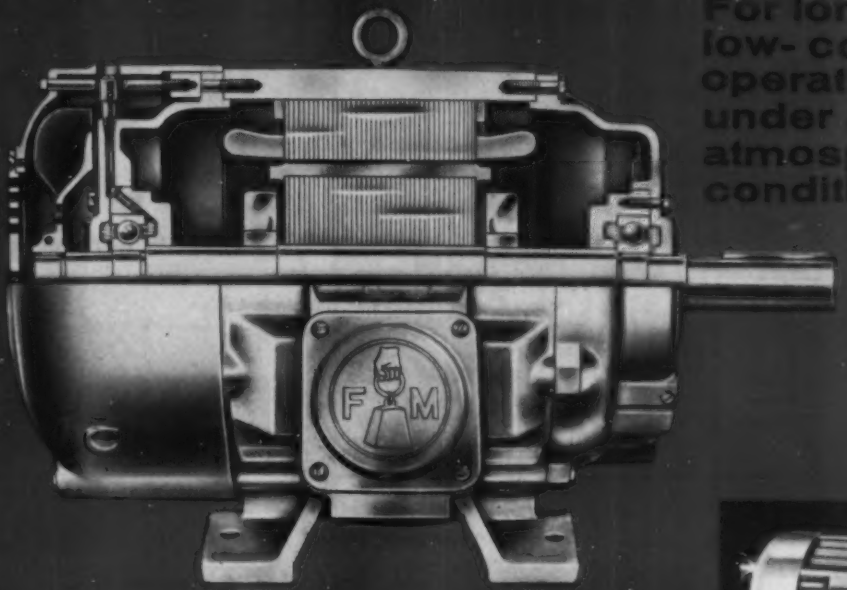
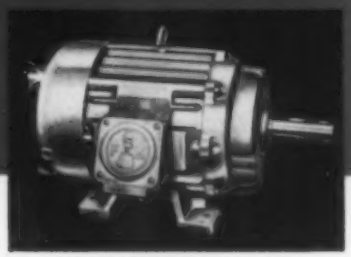
Here Is Your Motor

For long-life, low-cost operation under adverse atmospheric conditions





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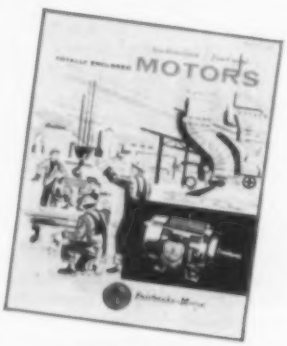
Fairbanks-Morse Totally-Enclosed Fan Cooled With Controlled-Stream Air Flow!

New Fairbanks-Morse design confines air stream to surface of motor—provides extremely efficient cooling, prevents dust and dirt accumulation. Combines advanced design innovations with long-proven F-M features.

See why these all-new F-M motors warrant your investigation *now* for severe service involving dirt, dust, metal turnings, or abrasive particles; corrosive vapors, steam, excessive moisture, etc.

Write today for new Bulletin 1205, giving complete information on new F-M Totally-Enclosed Fan-Cooled (Type KZC, in larger frames) and Non-Ventilated Motors (Type KZE, in smaller ratings). Fairbanks, Morse & Co., 600 So. Michigan Ave., Chicago 5, Ill.



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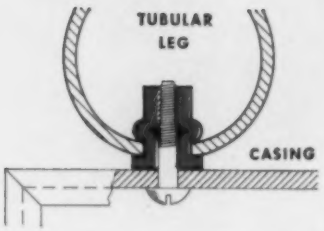
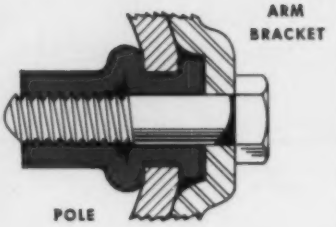
B.F.Goodrich

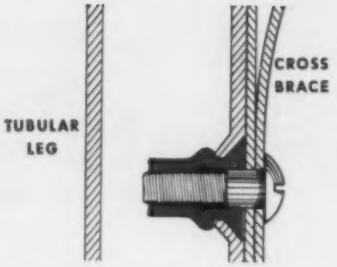
Only B.F.Goodrich Rivnuts® solve all these fastening problems so well



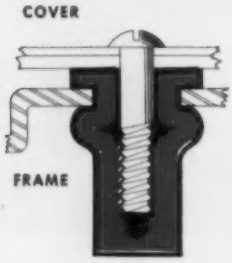
One man installs Rivnuts from one side in seconds—speeds assembly of *barbecues*. Permanent nutplates in legs save time in faster knockdown, too.



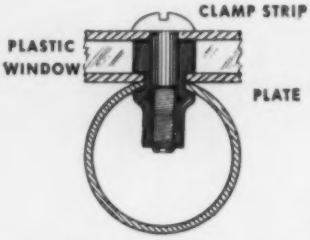
One man does the work of two, assembling arm brackets on *light poles*. Tests show pole or arm will fail before Rivnuts.



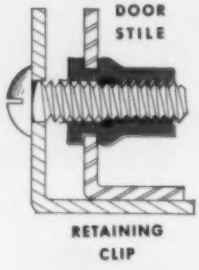
Clean, functional lines of modern *furniture* are preserved by Rivnuts. Upset inside tubular legs, they replace unsightly nuts, bolts and screws.



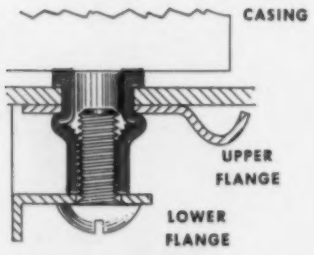
Rivnuts enable repair men to remove top of *automatic washer* and replace it easily. And Rivnuts can be installed after enamelling.



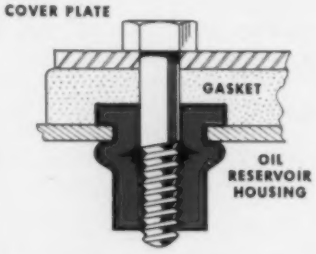
Upset Rivnuts secure *airplane window* plate to center post. Bulges in shanks seal out weather. Heads of Rivnuts serve as spacers for plastic window.



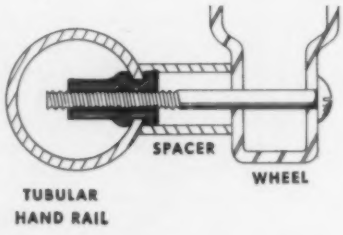
Rivnuts replace self-tapping screws used to hold retaining clips on aluminum *storm doors*, provide firm nutplates that won't loosen with shock or vibration.



Rivnuts eliminate need for reinforcing plates in *vaporizers*. In addition, Rivnuts space bottom flange automatically, prevent bending.



Assembly time for *oil reservoirs* is cut in half. Rivnuts eliminate welding, tapping and cleaning previously required to attach coverplate.



Wheel chair designers needed a blind nutplate with at least 6 clean threads. Rivnuts, only one-piece blind rivets with threads, were the answer.

Special fastening problems? B.F.Goodrich Rivnuts solve them. Send for free demonstrator. Dept. PE-98, B.F.Goodrich Aviation Products, a division of The B.F.Goodrich Company, Akron, Ohio.

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PRODUCT-DESIGN MEMOS FROM DUREZ

Selecting a molding compound | **Fire-retardant prepreg** | **Phenolic battery plugs**

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When you choose a general-purpose phenolic molding compound, how much emphasis should you place on *fast cure?*

If it's speed you want, you can get it—with Durez 265 Black. Cures on the order of 12 seconds have been run consistently.

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(We should mention that with Durez 265 you don't have to worry about consistency, even at this fast cure rate. Its uniformity is carefully controlled to insure reproducible results.)

Doesn't it make sense to be sure to choose a molding compound to *do what you want it to do,* rather than solely for the sake of a few seconds' press time?

Many think so. That's why we also stress Durez 791, 792, and 260 Blacks. Why so many? To give you best results under a host of varied conditions: 791 for greatest versatility; 792 for best dimensional stability; and 260 for easiest machinability.

If you'd like to examine for yourself the broad spectrum of properties you can get with these general-purpose compounds, just check the coupon now for data sheets.

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Now you can meet the most exacting requirements for reinforced plastic parts that must be strong, tough, and flame-retardant.

You get these properties in a new prepreg, made with Hetron® polyester, that eliminates weighing, mixing, and pouring of resin in your plant.

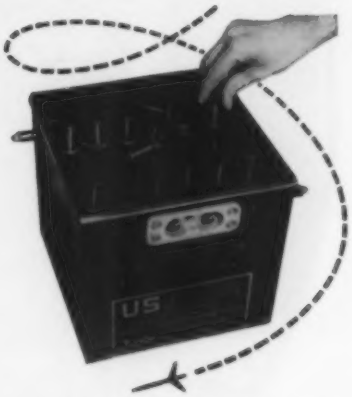
This material provides exceptionally high tensile, flexural, and impact strengths; smooth glossy surface; and excellent wet-strength retention. It is self-extinguishing without the use of additives.

The drapable sheet conforms to complex curvatures, facilitating layup. It is supplied in rolls up to 60 yards long, which have shelf life of six months or more under normal storage conditions.

For a list of manufacturers of prepreg materials, write us. For data on the Hetron resins with which they are made, check the coupon.

Neat stunt

Storage batteries that turn somersaults—and even do barrel rolls—create an



out-of-usual application for phenolics.

These stunting batteries provide ignition and emergency power for military planes. They also pose a design problem: how to vent the cells without losing electrolyte when a pilot puts his plane into a loop.

The answer: a vent with a lead-weighted valve that pops shut as the battery tilts to a predetermined angle, then opens as it returns to level.

Except for the lead weight and one rubber grommet, all parts of the vent plug are made of Durez phenolic. Molded-in threads and valve parts hold close tolerances to prevent leakage and perform within tightly defined limits of tilt, gas pressure, and force of gravity.

This is just one example of the versatility you command when you design with Durez phenolics. Your molder can help you put this versatility to work.

For more information on Durez materials mentioned above, check here:

- ☐ General-purpose phenolic molding compounds (data sheets)
- ☐ Hetron polyester resins (technical data file)

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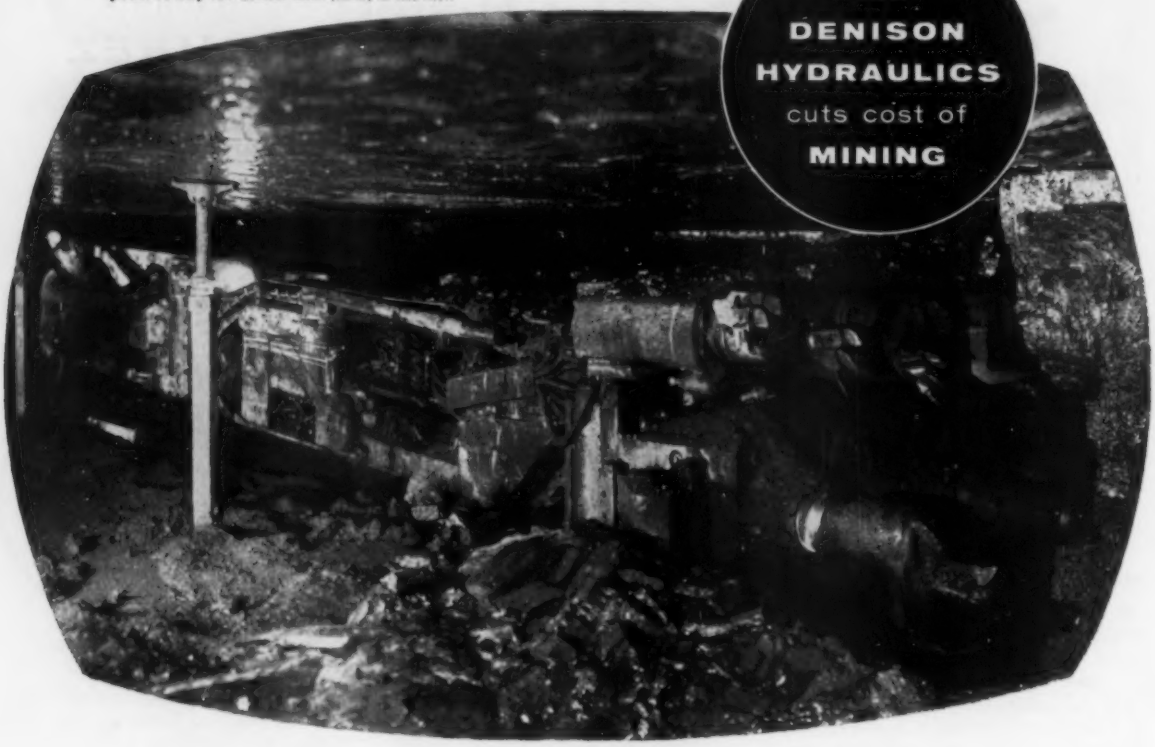
FAMOUS JEFFREY COLMOL®... continuous mining machine made by The Jeffrey Manufacturing Co., Columbus, Ohio—shown operating in 42" coal. Production: over 800 tons per shift. *Denison hydraulic equipment assures instant, dependable hydraulic power to help the Colmol mine faster, at less cost.*

How **DENISON HYDRAULICS** cuts cost of **MINING**



Instant-acting **DENISON** hydraulic power helps **JEFFREY** Colmol® devour over 800 tons per shift

TOUGH MINING doesn't stop Jeffrey's famous Colmol®. This powerful, compact continuous coal-mining machine works efficiently under the most severe operating conditions—producing over 800 tons per shift. *And the Colmol counts on dependable Denison hydraulic power for instant, accurate control that results in fast, low-cost mining.*

The Colmol's simplified, easily accessible hydraulic system includes a wide range of rugged Denison hydraulic equipment—four 2000 psi Vane-type Pumps... four Fluid Motors... plus flow controls, relief and check valves.

Three of the Vane Pumps power four Fluid Motors which drive the Colmol's two crawler treads, two discharge conveyor chains, and a swinging discharge conveyor chain.

The other Vane Pump operates 8 hydraulic cylinders which separate the Colmol's top and bottom head sections to adjust the breaker arms for working various coal seam heights... raise, lower and tilt the entire Colmol mining head.

Added advantages—Denison hydraulic power provides *infinite speed adjustment* for the Colmol. Simple hydraulic controls allow *one operator* to vary the machine's feed speed from zero to 46 inches per minute for mining... and from zero to 23 feet per minute for high or low-speed tramming in forward or reverse. This is *hydraulic flexibility that pays off* in today's modern mining operations.

It's another example of hardworking Denison hydraulic power doing jobs better... faster throughout industry. Your Denison Hydraulic Specialist can help with *your* next design problem. Write us for details.

HYDRAULIC DRIVE for the Colmol... begins with 4 Denison 2000 psi TMC Vane Pumps—shown assembled on gear case with electric motor attached. Three Vane Pumps power four Fluid Motors which drive crawler treads and conveyors. Remaining Vane Pump operates eight multi-purpose hydraulic cylinders.

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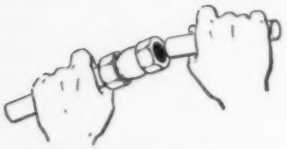
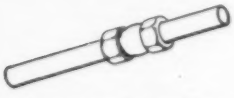


1. Stab pipe ends into factory assembled Dresser Fitting.

2. Tighten end nuts—takes only a few seconds.



3. And you're through! A permanently tight, flexible joint.

There is one simple way of joining equipment piping

Dresser® Compression Fittings enable you to design equipment with a complexity of piping . . . *without* the assembly, maintenance, and take-down problems of other pipe joining methods.

No elaborate equipment required for installation . . . no skinned knuckles or fumbling in tight quarters. A few turns of a simple hand wrench and you've got a *permanent, leak-proof* joint. The special compound Dresser gasket absorbs vibration, prevents pipe and equipment failure. The one simple, reliable way of joining pipe is the Dresser way.

Dresser's staff of highly qualified engineers may well be able to help you cut costs in the designing stage of your product. It will pay you to talk to them.

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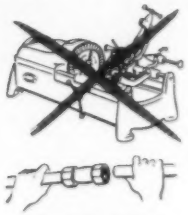
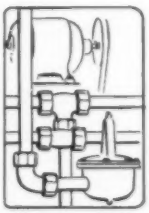
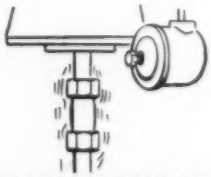
WHAT IT DOES



SAVES TIME—
No pipe threading or exact pipe lengths.



SIMPLIFIES INSTALLATION—
Permanent, leak-proof joints even with misaligned pipe (up to 6° deflection at each joint).



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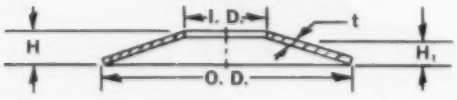
Check your requirements against these stock sizes

Part No.	O.D. (max.)	I.D. (min.)	t	H (approx.)	H_1	P_1 ±10%	P*
375-15	.375	.190	.015	.027	.021	35	55
375-20	.375	.190	.020	.030	.025	60	110
500-18	.500	.255	.018	.034	.026	45	70
500-25	.500	.255	.025	.038	.031	95	160
625-22	.625	.317	.022	.042	.032	70	105
625-32	.625	.317	.032	.048	.040	145	260
750-28	.750	.380	.028	.051	.039	110	175
750-40	.750	.380	.040	.059	.049	235	415
1000-35	1.000	.505	.035	.067	.051	175	260
1000-50	1.000	.505	.050	.075	.062	340	600
1250-40	1.250	.630	.040	.082	.061	230	330
1250-62	1.250	.630	.062	.092	.077	475	870
1500-45	1.500	.755	.045	.093	.069	284	400
1500-72	1.500	.755	.072	.107	.089	665	1180



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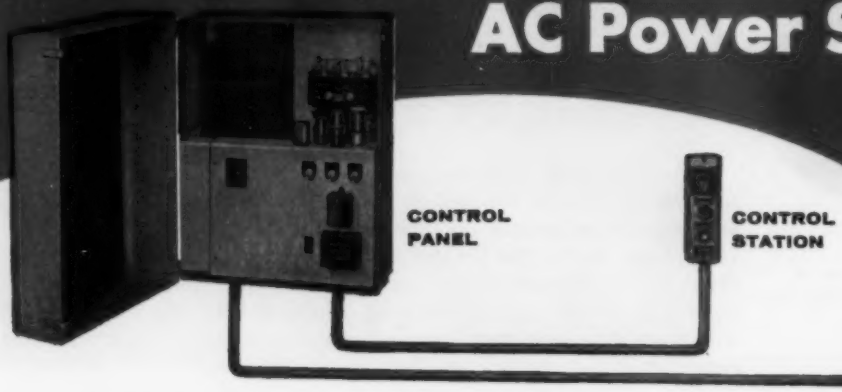
Drive Package Provides Infinitely Adjustable Speeds from AC Power Source



The complete Dynamatic power package includes all components required to provide infinitely adjustable speeds from an alternating current power source. A Dynamatic Ajusto-Spede® or Dynaspede® Drive, with electronic control and pushbutton station, satisfies the requirements of almost any application where proper machine operation or material processing depends upon control of operating speeds.

The compact control panel may be remotely mounted to conserve valuable space on the driven machine. The pushbutton station at the operator's position puts vital controls conveniently at the operator's fingertips and requires a minimum of space.

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Ajusto-Spede® Drives, available in ratings of ¼ horsepower to 75 horsepower, are air-cooled. Dynaspede® Drives, rated from 3 to 75 horsepower, are liquid-cooled. Raise your productive efficiency with Dynamatic eddy-current units.

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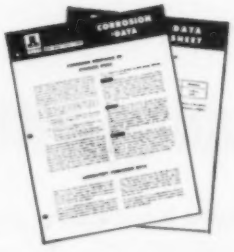

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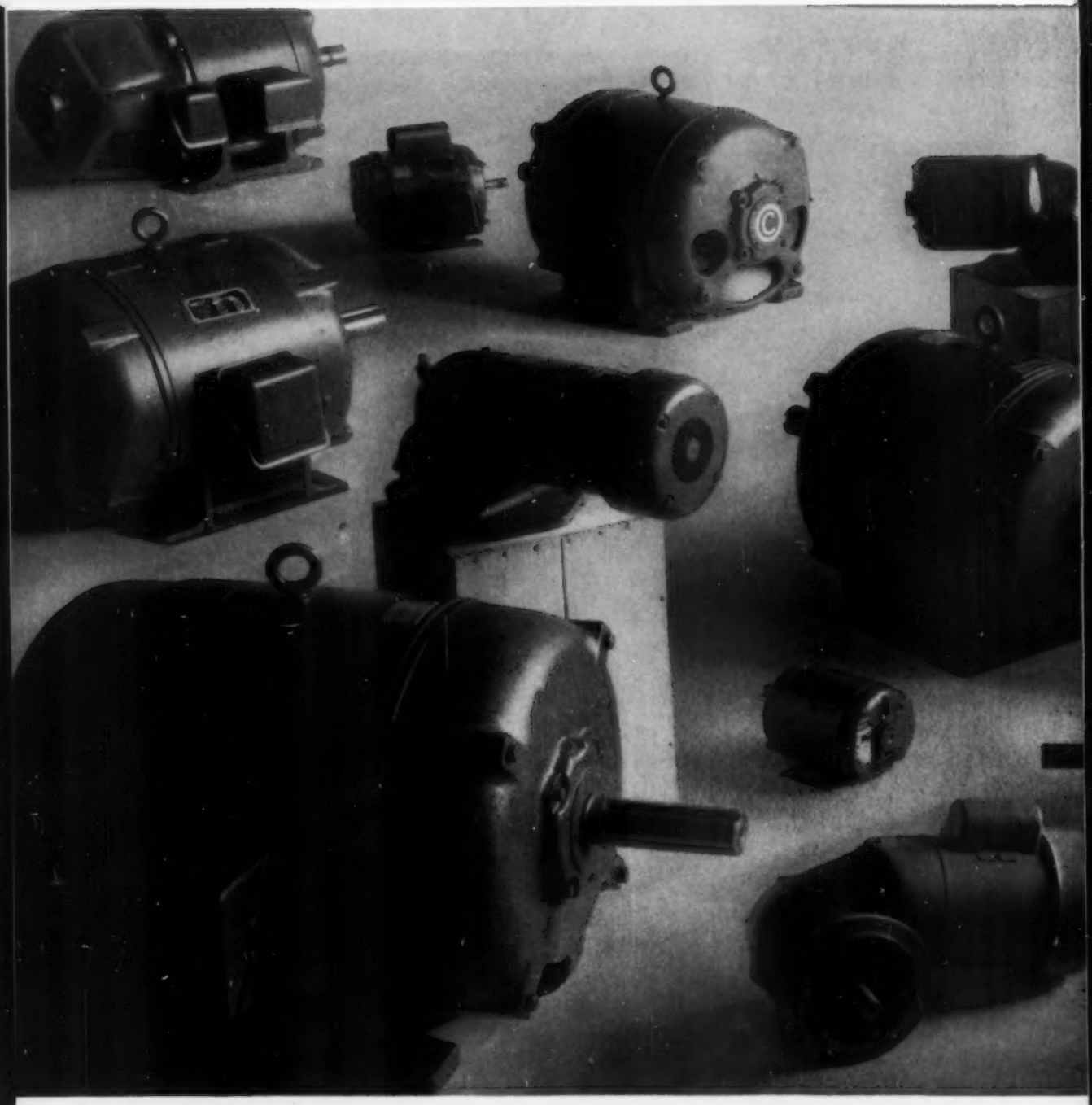

How you get more than just a motor

You get true design flexibility with

Suppose you have a particularly tough design problem—one that requires a specific motor to give the best results. You don't want to take a chance on not getting the right motor for the job.

This is where Century Electric's complete line of a-c and d-c motors, 1/20 to 400 hp, can be of help to you. You have a complete variety of motors from which to choose. Makes it lots simpler than shopping around to find what you need.

For help on your particular design problem, contact your Century Electric sales engineer. He has the know-how that comes from applying, engineering and thinking motors and nothing but motors day in and day out. If he can't give you on-the-spot

Century Electric's complete line of motors

answers, he has an experienced engineering staff backing him that can come up with quick, dependable answers to your problem.

This is why you get *more* than a motor when you take your motor and generator design problems to Century Electric. You get a quality product backed by know-how. You can call on men who want to help you get the right motor for your job. For more information, contact your local Century Electric Sales Office or Authorized Distributor.

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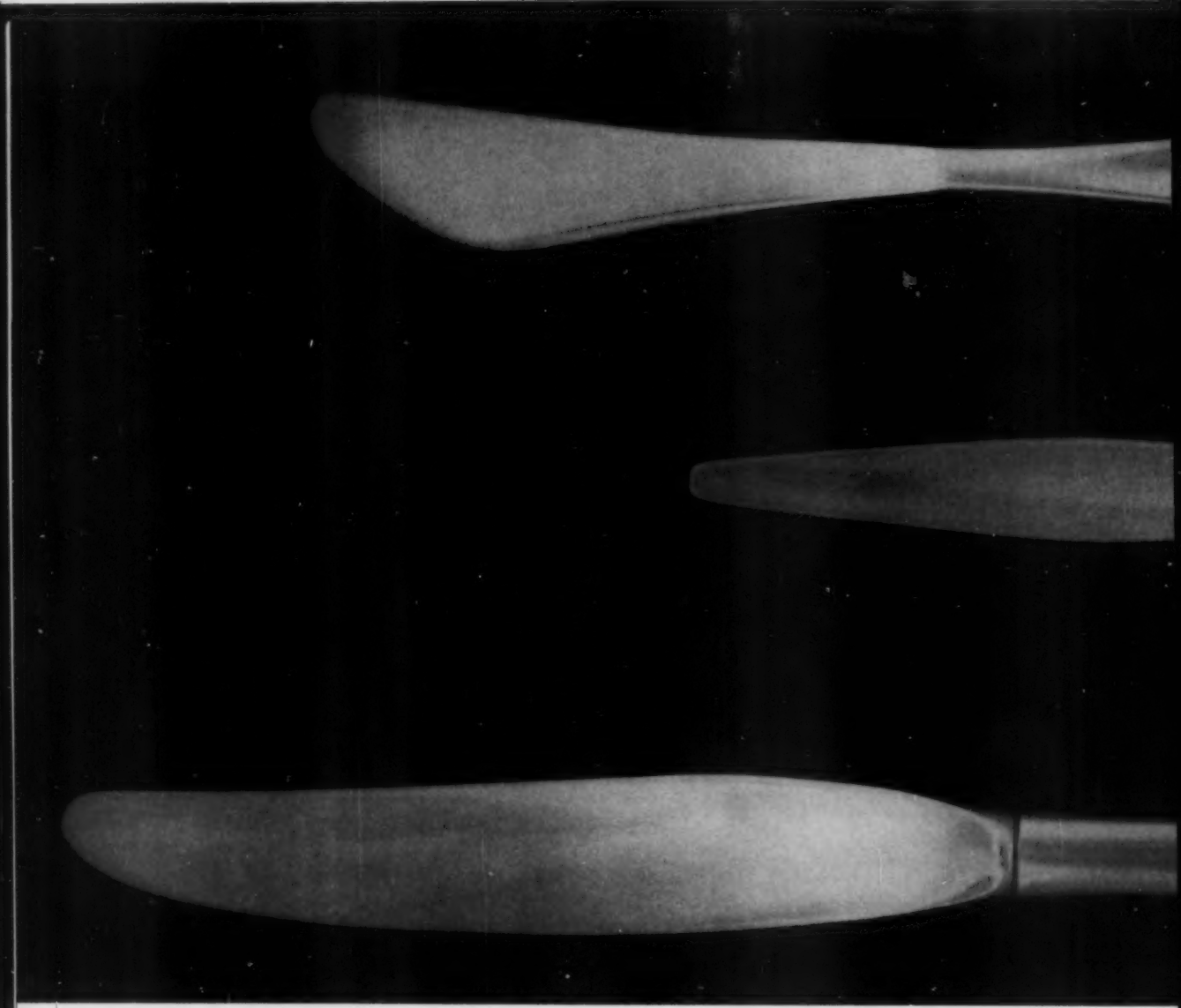

Good Design—Let's say that you were asked to design a *fish*. It's to be the most ferocious monster of the deep, a murderous creature ideally adapted to the sea. Chances are you would end up with something much like a 40-foot-long Great White Shark.

Then assume that you were asked to design the most efficient possible device to span a large body of water. You would very likely end up with something like the familiar high-towered suspension bridge.

You could then take these designs to any great artist and he would say, "They are beautiful"—even if he didn't know how or why you had designed them.

Why are they beautiful? Probably because they are so absolutely functional. In the astringent design of a fish or a bridge, lines are curved only when they should be curved—to add strength or streamlining. *Materials* are used functionally, too. You don't make a shark's tooth from cartilage. You don't make a suspension bridge from anything but steel.

As we develop more and more "styled" products, the choice of material becomes very important. For example, the flatware industry has been revolutionized by Stainless Steel because of its unbeatable combination of luster, strength, corrosion resistance and formability. The landscape gleams with steel curtain wall buildings as we learn to use steel in bold, bright, colorful ways. Even huge power shovels take on a new beauty as ultra-strong steels slim their silhouettes.

It's the same story with thousands of other products. And for any application, there is one steel best suited for the job—one that contains physical properties, appearance and price in the right package. It can be selected from the large family of USS Design Steels: Carbon, High Strength, Alloy and Stainless.

Any time you want help in making that selection, call United States Steel, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

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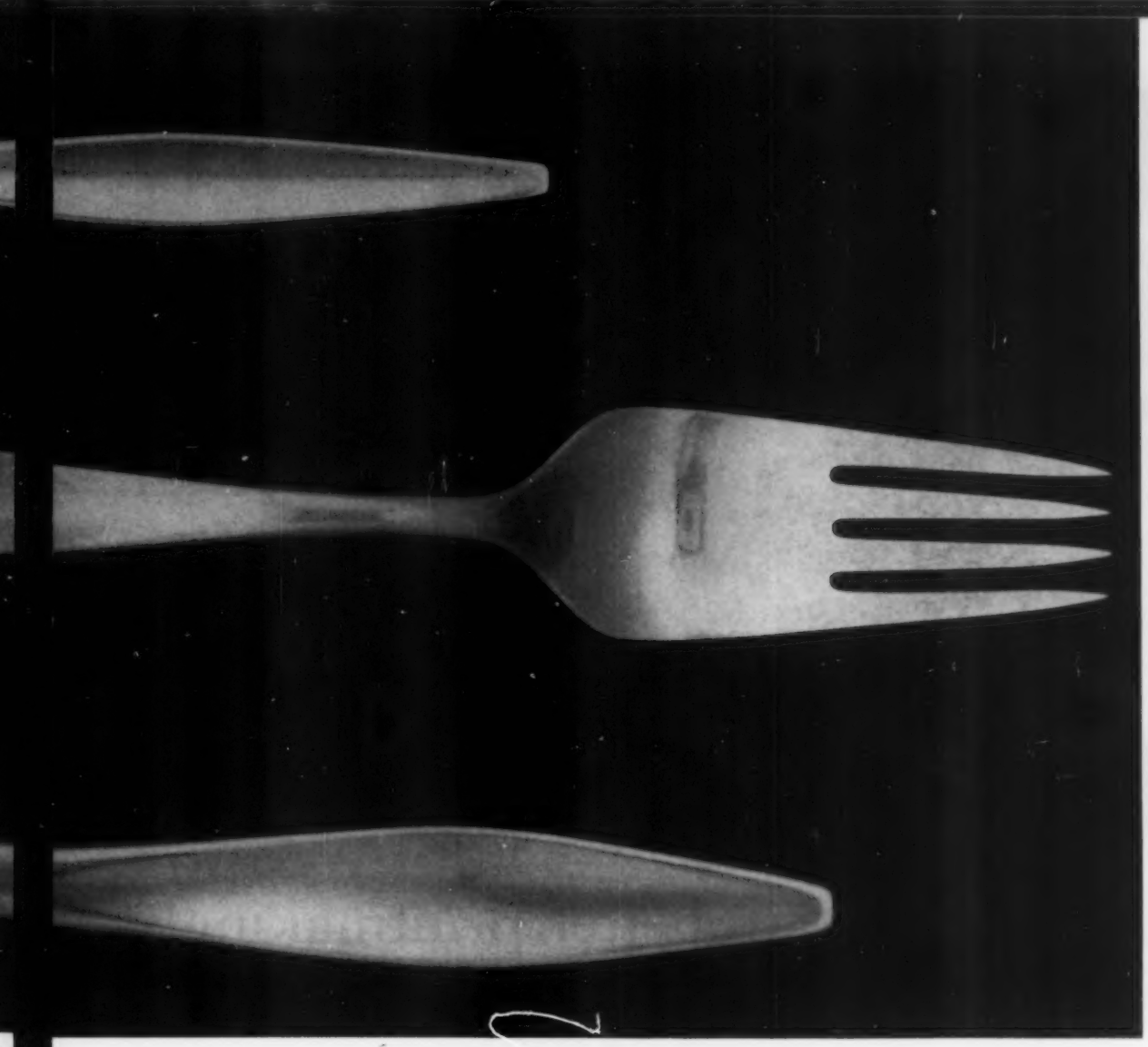
USS United States Steel

STEELS FOR DESIGN

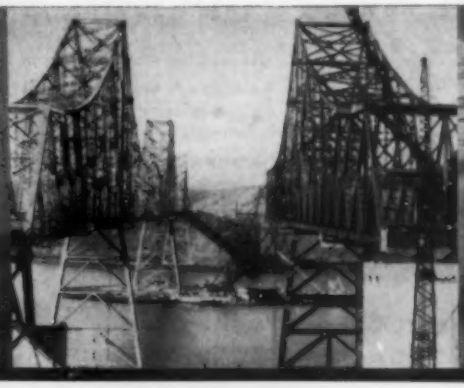


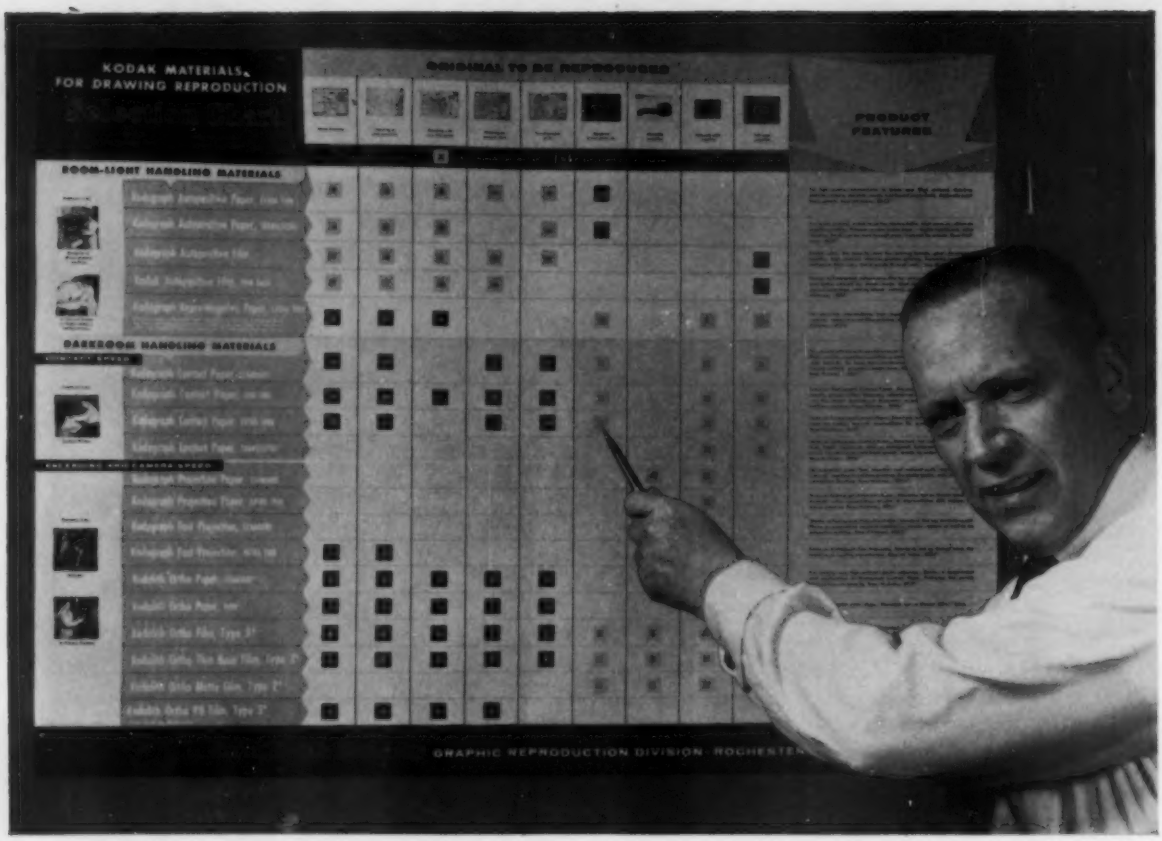
Lower Left: Problem: Combine ruggedness, safety, and beauty in a pleasure yacht. Solution: Designer used USS COR-TEN High-Strength Low-Alloy Steel. Pay-off: Hull is stronger and more resistant to corrosion. Welded construction allowed separation of the gasoline and bilge areas, helps eliminate the most common boat disaster—fire. Formability of COR-TEN made it easy to shape the sleek, curving hull.

Lower Middle: Match profile of a new cantilever bridge (right) with existing bridge, but build it stronger to support wider roadbed. Solution: USS "T-1" Constructional Alloy Steel (now available at 100,000 psi min. yield strength) and USS TRI-TEN High-Strength Low-Alloy Steel. Pay-off: "T-1" Steel alone saved $800,000 by slimming down massive members. All shop connections are welded. "T-1" 's weldability enabled clean, graceful members contrasted to laced and riveted members in old bridge.

Lower Right: Problem: Portray 20th century Pittsburgh in a metal mural for a Pittsburgh hotel. Solution: Artist selected Stainless Steel for most of the job. Pay-off: A mural that is permanently beautiful. Says sculptor Rene Shapshak, "This is the Stainless Steel Age."

USS, "T-1", Cor-Ten and Tri-Ten are registered trademarks





Quick guide to better printmaking

FREE... this handy wall chart lets you put your finger right on the Kodagraph Reproduction Material which will give desired results in reproducing all types of drawings or other originals in all types of printmaking equipment.

Whether you do your own printmaking or order from a local blueprinter, you will find this chart a big help in the drafting room.

It tells you, for example, which Kodagraph Materials give you sharp, clean intermediate prints of old soiled drawings; which ones are best for reproducing blueprints, microfilm negatives, drawings with extremely fine detail.

In addition, this chart (printed on durable plasticized paper) brings you up to date on all the materials in the versatile Kodagraph and Kodalith lines. Saves you thumbing through pages of data books for information. *Well worth sending for today!*

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Graphic Reproduction Division, Rochester 4, N.Y.

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- **Kodagraph Autopositive Paper Extra Thin** for high-quality photographic intermediates at lowest cost.
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- **Kodagraph Autopositive Film** for very fast-printing intermediates of highest quality.
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- **Kodagraph Repro-Negative Paper** for black-line intermediates from negative-type originals.

Kodak
TRADE MARK

PERSPECTIVES

in design and development . . .

New Life for Reciprocal Trade

Congress has given the President much of what he wanted in the way of an extended reciprocal trade agreements program. But it won't mean cheaper foreign imports in the immediate future. And between now and 1962, when a new round of tariff cuts will be negotiated, domestic producers will have better chances for new protective boosts.

Basically, the new law extends the old law for four more years, with authority for the President to cut existing tariffs by 20% at any time. But there are important loopholes. Because most of them are permissive rather than mandatory, how the program is administered will govern whether they will mean new trade protection for domestic producers.

The Office of Defense Mobilization, when weighing tariff or quota boosts for domestic industries, must now consider the general affect of imports on the economic well-being of domestic producers. Under the new law, it will be easier for domestic producers to apply for—and get—tariff protection on grounds of threatened injury or "defense essentiality." Also, along with passing the trade bill, Congress approved—in separate legislation—some changes in the 1921 anti-dumping act. Domestic producers will now find it easier to get punitive duties on imports found to be entering at less than "fair value" and threatening injury to US competitors.

Key to the Future

Future developments depend mainly on the all-important European common market. It is scheduled to work out a common external tariff early in 1962, hence major European trading countries cannot sign extensive new trade agreements with the US or anyone else until then. And because the general agreement on tariffs and trade (GATT) binds its signatories to the so-called most-favored-nation clause, GATT-members outside Europe will not be able to rejigger their tariffs significantly until they know the new common-market rates on specific items. The "most-favored" clause in effect says that when one nation signs a trade pact with another, it must offer the same tariff rates to all other GATT members.

It is because the European market needs at least four years to get going that President Eisenhower wanted at least the four-year reciprocal extension he finally got. The White House and Congress liberal-traders argued convincingly for authority to talk tariff cuts with other nations at least through 1962.

Aside from new US trade pacts, existing ones may be altered before the four-year target date. But it would take even minor adjustments required by US Tariff Commission or ODM at least two years to put into effect.

However, Congressional approval of the trade bill is important as a psychological symbol. It tells the rest of the free world that the US intends sticking to an over-all policy of at least striving to cut tariffs further and expand world commerce generally. Also, because most of the fat already has been cut out of US tariffs, the 20% reductions authorized in the new law may have more qualitative effect on the market than previously, even though relatively small in a quantitative sense.

Adding up, economists see no major shifts in US trade patterns for some time to come.

—Paul Anderson

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Product Engineering **HORIZONS**

September 15, 1958

design apologies

France built the Maginot Line, Germany the Siegfried. Both were broached without too much trouble by attack, because both were dictated by defensive thinking. Both nations forgot the old rule that "the best defense is a good offense." Both neglected the fact that the advantage lies with the attacker because he can choose the place and time of attack.

Much the same defensive thinking dictates present-day designs. The Army has just proudly announced electronic earmuffs for tankmen that generate noise of equal intensity but opposite phase to that of the tank; thus the two noises cancel each other out. But what of design to reduce the noise in the first place? The Army also has a new vest with pockets for small storage batteries—to keep the batteries warm so they won't freeze. What of batteries designed to resist freezing?

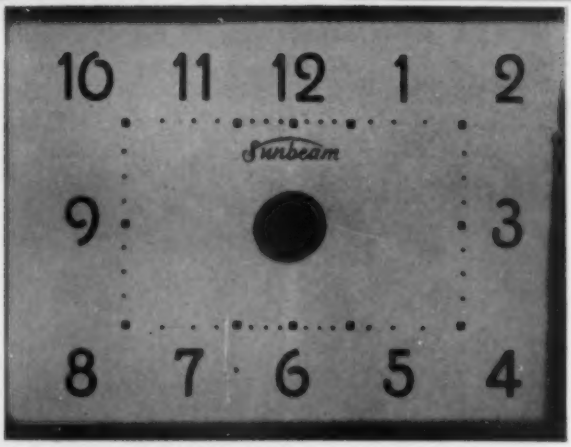
What of the elaborate safety gadgets we design for presses and machine tools? Why not design the machines to be safe? The first positive step in this direction is automated equipment that subtracts the man, and thus the accident potential.

There are endless examples of design apologies—compromises—that are secondary solutions because we haven't found the primary one. The danger is that the search for the primary one will be abandoned because we can use the secondary one as a crutch.

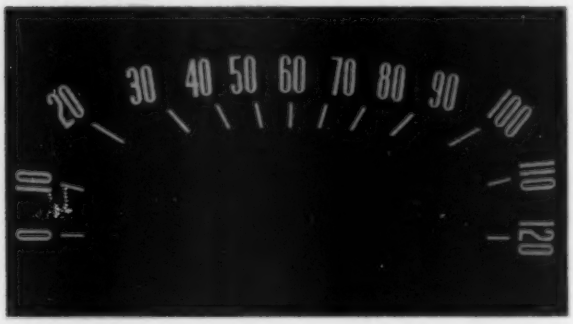
Some years ago, a designer of machine tools caused competitors real trouble by using Fork-truck gearboxes (at $23) for speed-shift transmissions (at ten times $23). He also could provide any desired column height with a cutting torch—because he used steel pipe for the column instead of a casting.

A Canadian tool designer made the first nonadjustable and non-shifting aircraft fixtures by utilizing the principles of bridge-building. Some of our recent production processes overcome the bugaboo of chip disposal by doing "chipless machining"—roll and press forming, thread rolling, hubbing, investment and die casting, powder metallurgy. And for equipment that must be kept clean, positive pressure inside enclosures makes periodic removal of dirt unnecessary.

These are all positive solution to problems, they remove the criminal rather than guarding his intended victim. They are not design apologies but new thinking that eliminates a problem rather than defending against it.



Glow-in-the-dark panels . . .
are now commercially available for use in clocks (above), instruments (below), radios, air conditioners, automobiles, aircraft. The two pictured here are made by Sylvania.



from
Jumpy Electrons
comes

ELECTROLUMINESCENCE

NEW AREA-SOURCE OF LIGHT

Here's a radically different kind of illumination—no white-hot filaments, or arcing, or activating rays needed. Already, the new light is glowing in many products (one of them will be seen in a 1960-model car). The panels can be formed to shape, need only a trace of current, will last 30,000 hours or more.

ANNESTA R. GARDNER, *Associate Editor*

The possibilities in electroluminsecence are exciting enough to warrant a close look at this glow-with-a-long-name. They include selective information-storage and display . . . controlled light-amplification . . . cool, flexible, efficient lighting.

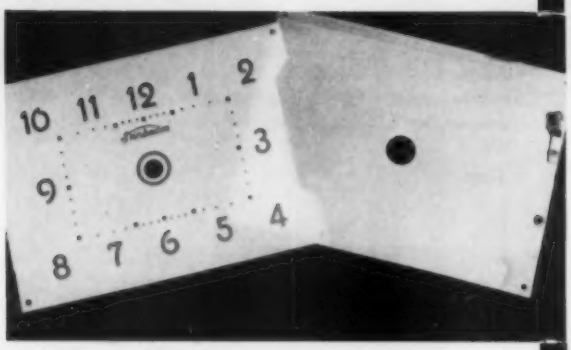
How does the new light source with phosphorescence and fluorescence? Quite closely in the visual result. But, and this is important, an alternating voltage, instead of cathode rays or ultraviolet light, excites electrons into the energy-level changes that produce the effect.

This difference explains why electroluminescence is worth considering when the other light sources are already available—it produces an area source of light that is basically simple, versatile, and efficient.

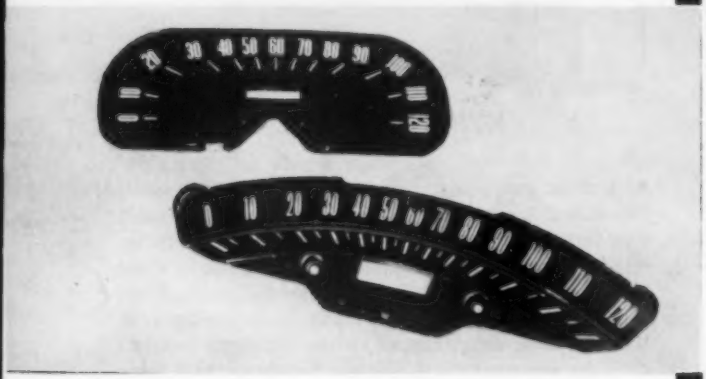
All that's needed is an alternating electric current and a phosphor suitably mounted and coated. That means electroluminescent sources are potentially unlimited in size and shape. They are area emitters that can be made in flexible as well as rigid form, and in a range of colors. There is no reason, for instance, why such a source could not be wrapped around a pole, or coiled into a rope. Indeed, flexible sources have already been produced in the laboratory.

WHAT YOU CAN BUY

Commercially, electroluminescent paneling is on the market, for a good many applications. Panels to provide a glowing source of light for clock-radio and instru-



Transparent overlay . . .
at left has numbers which become visible when underlying panel (right) lights up. Overlays can also change color of light, allowing panel designer to take advantage of most efficient phosphors.



Shape of part . . .
markedly affects cost of electroluminescent paneling. Formed speedometer panel (bottom) would cost 6 or 7 times as much as flat panel (above); yet difference in appearance is negligible. To make these panels, Sylvania silk-screened numbers on base.

ment dials, air-conditioner controls and the like are available: in metal, sizes to 7 by 14 in.; in glass, to 30 in. square. One upcoming application: dashboard panels for one of the "Big Three" 1960-model cars *(PE—Aug 18, p. 17)*.

Cost depends on quantity ordered, complexity of the shape in which the panel must be made, and whether or not an overlay is used. Sample panels for evaluation are sold at a flat rate of $1 a sq in. by one producer; and 12-by-12-in. glass panels for $30 by another. But commercial cost is far less. A green-lighted dial face, for instance, need not cost more than $1 in production quantities: in large volume, might run less than half that much.

A panel of this type has a conductive base of metal, or glass with a conductive coating; a layer of phospher that is generally ZnS; a transparent electrically conductive

The Explanation—Jumpy Electrons

Electron "holes" and controlled "impurities" are the key to electroluminescence, most experts believe.

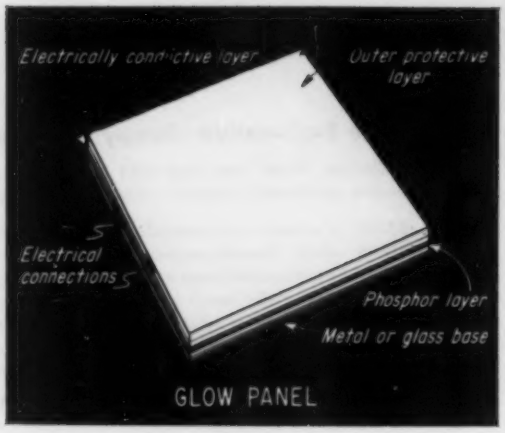
BASIC IDEAS A primary characteristic of the compounds which electroluminesce is—their electrons can exist at several different energy levels. Normally, they remain at the lowest level. But under stimulation of an alternating electrical field, they will jump to a higher level—if an opening or electron "hole" is provided. When the stimulation is removed, they tend to drop back to their original level, giving up part of their extra energy in the form of light. Apparently, that jump between energy levels is often a long one—too long for most electrons. To help them along, "impurities" such as copper atoms may be added to serve as intermediate steps.

COLOR & BRIGHTNESS These "impurities" not only promote the luminescent effect but also, in many cases, affect its color. Copper atoms, for instance, make the phosphor glow green; and, because copper seems the most effective "booster," green panels are today the brightest and most efficient—at low and moderate voltages, at least.

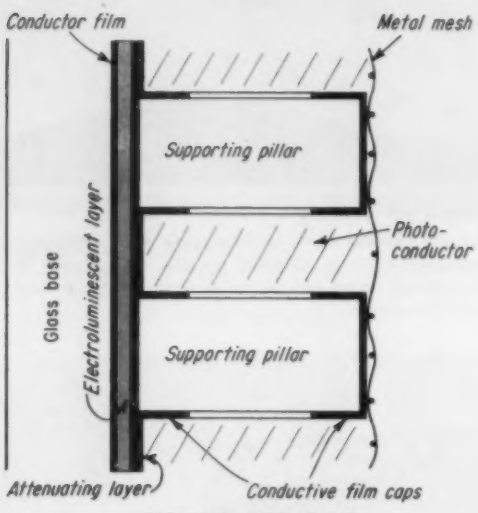
EFFICIENCY If all electrons freed by the electrical current jumped to a higher level, electroluminescence would be an efficient system indeed. This is not the case. Many cannot make the jump, many waste their energy in collisions with other electrons and other atoms. This is the problem receiving major research attention today; it is hoped that, by proper selection and combination of phosphor compounds, efficiency can be markedly increased.

VOLTAGE FREQUENCY & INTENSITY The electron "hole" theory also helps explain another observed effect, the fact that intensity of the electroluminescent light may be increased either by increasing the strength (voltage) of the electrical field; or by increasing its frequency. When voltage goes up, the theory says, more electrons are freed, more holes are created—more chance that electrons will move to a higher energy level. When the frequency is increased, electron holes are created faster so that, again, the total number is increased. However, in both theory and practice, increased frequency also seems to bring an increase in wasteful collisions, explaining why efficiency drops as frequency increases above a certain point.

RELATED DEVICES If terms like "electron holes" and "controlled impurities" sound familiar, this is because they play a major role in the theory behind many of the new "solid state" devices, including transistors. Indeed, most of the electroluminescent phosphors are semiconductors, like germanium and silicon; and many such phosphors can also be activated by ultraviolet light or X-rays—explaining why they will serve in fluorescent lighting or fluoroscopic devices too.



Glow panel and moving-dot panel . . .
are diagrammed here. While individual manufacturer's designs vary, all follow these basic patterns. Note relative simplicity of the glow panel; the other is designed for information display.



How Voltage and Frequency Affect 3 Types of Electroluminescent Panels

VOLTAGE	BRIGHTNESS, IN FT-LAMBERTS*					
	at 60 cps			at 400 cps		
	Green	Blue	Yellow	Green	Blue	Yellow
120	0.5- 0.75	0.08-0.25	0.05-0.1	2.5- 3.0	0.3- 0.7	0.1-1.2
240	2.0- 3.0	0.5 -0.8	0.2 -0.5	5.0- 7.0	2.0- 3.0	0.6-1.5
600	8.0-10.0	2.0 -3.0	1.0 -2.0	25.0-30.0	6.0-10.0	2.0-4.0

* Figures are for commercial metal-based panels of the three colors

coating and a protective ceramic coating. An alternating voltage, applied between the conductive base or metal electrode and the protective coating, produces the glow.

IT'S A SOFT GLOW

As yet, the light output of such sources is not great. In the brightest color, green, the paneling most widely used today supplies only about one foot-lambert on a standard 110/120v, 60-cps circuit. (For comparison, the brightness of a TV screen is 15 to 20 ft-lamberts and a 40w "cool" fluorescent is close to 2,000.) Intensity increases higher voltage and frequencies, but would require a frequency of 20,000 cycles or so to rival intensity of the ordinary fluorescent bulb. However, remember that electroluminescent panels are still in an early stage of development. Intensity of commercial panels today is five times what it was two years ago, and there is every reason to expect light output will be increased.

Most of the present paneling is of the green type. Phosphors in other colors are still low in intensity (less than 0.1 ft-lambert at standard frequencies). When other colors are needed, designers find it usually better to overlay with a red or yellow filter than to use a phosphor that itself glows in the desired color.

The overlays can considerably increase design flexibility and decrease cost. Example is a clock radio soon to be introduced. To provide over-all electroluminescent lighting for a large dial face and big numbers would have been quite expensive. Instead, the overlay covers only the central area. The big numbers are outside; easily seen in the daytime, they need no lighting. A number-carrying overlay is provided for nighttime use. These numbers are smaller, but still legible, and they do not show until or unless the light level is low enough for the glow to be seen; then, of course, the bigger numbers can't be seen.

As far as power requirements and durability go, electroluminescent panels already fulfill their promise. Power drain is extremely low (less than a milliamp/sq in. at standard voltages); and, at these voltages, almost no heat is generated. The cost of operating a dial face panel—4 by 6 in. perhaps—for a full year would be only 2 or 3¢; and the panel would barely feel warm to the touch. Furthermore, manufacturers claim service life will be 30,000 hours or more. That's about four times the life of the average fluorescent lamp (7500 hr) and 30 times that of an incandescent bulb. In efficiency, though, electroluminescent panels still have far to go.

HOW THEY COMPARE

The best ones, operating at optimum voltages and frequencies (120 to 600 v; 60 to 400 cps) give an efficiency of about 12 lumens per watt. At the brightness of higher frequencies, efficiency drops to 1 lumen per watt. Fluorescents on the other hand, provide about 67 lumens per w; and even incandescents, for all their heat generation, give 16 to 23 lumens.

At present, electroluminescent paneling is available commercially from two sources: Sylvania and Westinghouse, with the former concentrating on metal and the latter on glass. A third company, GE, is actively researching this field, and offers a number of interesting reports, but has not yet started commercial production.

Flexible panel . . .
is produced at Westinghouse laboratory by using metal mesh as base for phosphor, aluminum foil as conductive and protective covering. Such panels are still in development stage.

So much for what is ready now. But what about the laboratory demonstrations that have been attracting attention in the past year or two? The platter-thin TV sets . . . image-producing and information-display panels that make radarscope "pictures" look like finger-paintings . . . light-amplifiers that really see in the dark . . . complete-area lighting systems? These are by no means impractical; but their commercial introduction must await development of new phosphors, new coating techniques and new electrical circuits.

THE FANCIER KIND

Image-producing and moving-dot panels (information-storage and display ones, for example) are considerably more complex than those designed for lighting, though they follow the same basic layered construction.

One type of image-producer consists of a base (generally glass with an electrically conductive coating), an electroluminescent layer covered by black glass coating, a photoconductive layer, and a metal mesh. Power is applied between the conductive film on the glass at the front and the metal mesh at the rear. Then, when an optical image (photograph or motion picture) is projected on the mesh, a visible–and amplified–picture will appear on the luminescent face. Since the panel is especially sensitive to the longer wavelengths, infrared can be used for projection, and the amplification–by conversion of "invisible" rays into visible ones–is considerable.

Moving-dot panels, designed to produce and control a dot of light which can then be used as an indicator or actuator, are quite different. Here, the electrically conductive layers are thin, parallel strips which must be held to close tolerances. These conductive strips are applied, one below and one above the electroluminescent layer, at right angles to each other. Then, when a source of ac power is applied between them, a dot of light appears at a point where the strips cross, and this dot of light can be made to move or to take any desired position.

Still more complex, as might be expected, are the "mosaic" or multiple-dot panels, designed for radar-type displays and computer "memories." Here, a photoconductive layer, in the form of columns or pillars leading into the electroluminescent layer, is added to the basic panel, providing in effect a series of tiny electrical connections by means of which the dots of light may be controlled. An ac power source is connected between the conductive film on the base plate and the metal mesh at other side of the panel. When the photoconductor is in the dark, its resistance is high enough to prevent the applied voltage from appearing between the conductive caps on the pillars and the conductive film on the base plate. But when activated by light, the photoconductor allows current to get through, establishing a connection and activating the phosphor in the area directly beneath a particular pillar, thus producing a dot of light.

PANELS OF THE FUTURE

Much research remains to be done–on phosphors, panel design, and base materials–before image-producing and moving-dot panels reach practical use.

It may be a good idea to think of electroluminescence as a three-phase development. In the first, already being fulfilled, it is a new type of lighting for clock dials, instrument faces, and control panels for slide projectors and room air conditioners. The second, still in the laboratory but in advanced development, includes image-production and light-amplification, and such refinements as flexible elements. Close to application, too, are light sources for office copying-machines.

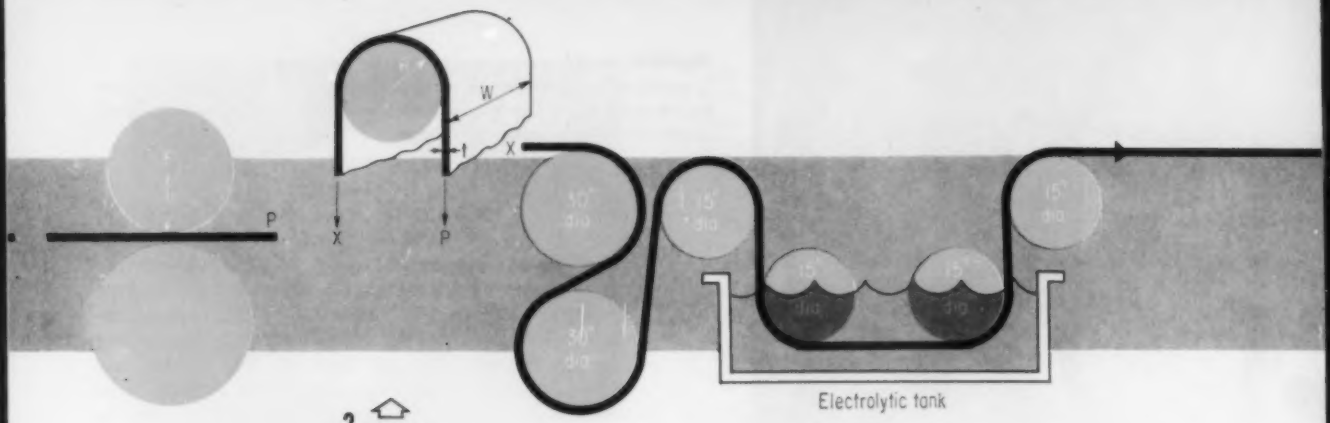
The third, well in the future, is electroluminescence for room lighting–the glowing walls and ceilings that may someday provide lighting for a whole room.

Today, then, electroluminescence makes it possible to use light in many places where it never was used before. Control panels for room air conditioners are a good example. Here, it is often desirable to change the setting at night; a faint, glowing, area source of light becomes valuable. For the present, though, the designer would do well to remember that many of the most exciting possibilities of electroluminescence are still in the future, and to paste this note on his board: Make it simple; make it green; and don't expect much more than a glow.

REPRINT of this article can be obtained for your reference file by checking No. E41 on one of the Reader Service cards bound in this issue. For other reprints available see "Current Reprints" listing in this issue on page 153.

EDITOR'S NOTE: For an over-all view of the semiconductor field, see "Semiconductors—Revolution at Hand," Apr 14 '58, p 60.

Information on specific semiconductor devices is given in "Transistors vs Tubes for Industrial Applications," Oct 28 '57, p 52; and "Germanium and Silicon Take the Lead Among Semiconductor Rectifiers," May 12 '58, p 89.



1 BASIC PINCH ROLLS

2 BASIC BRIDLE ROLL

3 NINE-ROLL CONVEYOR USES BRIDLE ARRANGEMENT FOR . . .

how to design CONVEYOR ROLLS for DRIVE or DRAG

It's the way the rolls are grouped that determines how well they will grip and move a continuous strip of metal. Illustrated above are five such groupings. Author describes forces involved, in terms of working equations and examples.

LAURENCE H. AUSTIN, *Design Engineer, United Engineering and Foundry Co*

When you see conveyor rolls firmly grip and move a continuous strip of metal there is more than meets the eye. How much power is needed to drive the strip? . . . how much drag to keep it from sagging as it transfers through a processing station such as annealing furnace, punch press or cold-roll mill? . . . and especially, how will different roll arrangements influence conveyor design?

One basic method of gripping the strip involves a pair of pinch rolls—they squeeze the strip between them. The other common way—with bridle rolls—causes the moving strip to bend over and around one or more rolls. Either method can serve to drive the strip (for this, rolls are usually at head of the conveyor line), or drag on it to prevent its sagging.

PINCH ROLLS

Drag developed by pinch rolls, Fig. 1, at point of contact is:

$$I = I\mu$$

Often, weight of the top roll will cause sufficient drag. If not, pressure can be increased by pneumatic or hydraulic means. The above equation also holds true when the rolls are employed to drive the strip.

BRIDLE ROLLS

Some materials are too soft to be transported or retarded by pinching. Others have surfaces that would be marred by pinch rolls. Such conditions call for bridle rolls. They do their work more smoothly by developing a drag force as the strip bends around the rolls, Fig. 2. The drag created by one roll is computed from an equation that assumes the material to be in a combined plastic and elastic state:

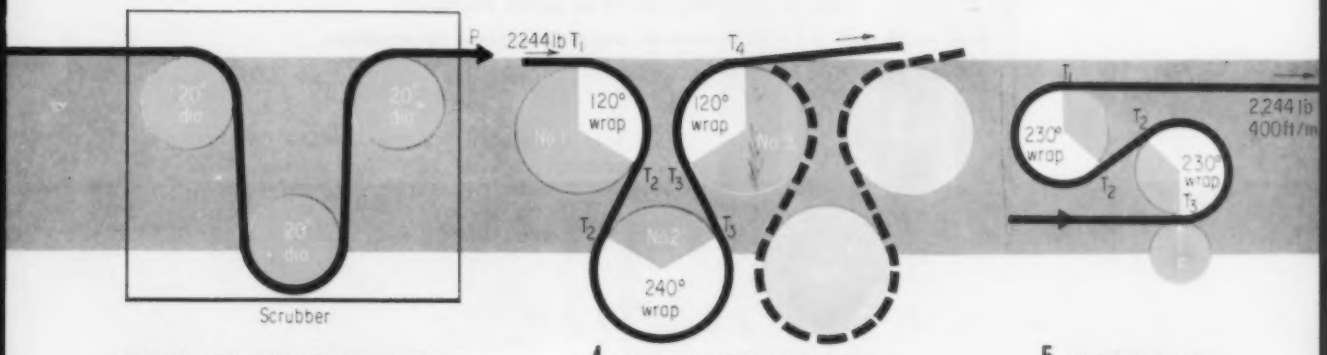
$$P = \frac{S^2 W}{5R}$$

Thus, assuming $S = 30{,}000$ psi, $t = 0.09$ in., $W = 48$ in. and $R = 15$ in., then drag force will be:

$$P = \frac{30{,}000(0.0081)(48)}{5(15)} = 155 \text{ lb}$$

Here friction in the roll bearings is considered negligible. Weight of the suspended strip of metal causes the counterbalance force X and should be added to the force required to pull the strip over the roll.

If no permanent deformation takes place, the extent of constant, θ, (180° in this case) does not affect the pull because energy expended in bending the strip onto the roll is recovered when it straightens coming off roll.



DRAG IN CLEANING-SCRUBBING PROCESS

4 BRIDLE-ROLL ARRANGEMENT USED FOR DRIVE

5 COMBINATION OF PINCH AND BRIDLE ROLLS

However, this angle is important in computing the power to pull a strip through the bridle rolls.

To compute total force required to pull the strip through a series of bridle rolls, such as with the electrolytic tank and scrubber, Fig. 3, simply make allowances for different roll diameters by multiplying the drag force for a 30-in. dia roll (155 lb) by the ratio of diameters—then add up the forces.

$$\text{2 rolls at 30-in. dia} = 2 \times 155 = 310 \text{ lb}$$

$$\text{4 rolls at 15-in. dia} = 5 \times 155 \times \frac{30}{15} = 1244$$

$$\text{3 rolls at 20-in. dia} = 3 \times 155 \times \frac{30}{20} = \frac{690}{P = 2244 \text{ lb}}$$

POWER CALCULATIONS

In the same example you could use pinch rolls at the head of the conveyor line to drive the strip by coupling a motor to one of the rolls. However, assuming $\mu = 0.3$, this would require a pinch force of $F = 2244/0.3 = 7480$ lb. This force may mar the material and overload the roll bearings.

A better driving method would employ three bridle rolls—rolls 1, 2 and 3 in Fig. 4. Here the #3 roll is coupled to a power source. Assuming the desired line speed is 400 ft/sec, then for 36-in.-dia rolls, the ratio of effective tensions for roll #1 will be:

$$\theta = 120° = 2\pi/3 \text{ radians}$$

$$T_1/T_2 = e^{\mu\theta} = e^{0.3(2\pi/3)} = 1.874$$

$$T_2 = 2244/1.874 = 1197 \text{ lb}$$

$$P_1 = 2244 - 1197 = 1047 \text{ lb}$$

$$\text{horsepower}_1 = \frac{P_1 V}{33{,}000} = 12.7$$

Using the same procedure for rolls #2 and #3 gives: $T_3 = 341$ lb, $hp_2 = 10.4$, $P_2 = 856$, $T_4 = 182$ lb, $hp_3 = 1.9$, $P_3 = 159$ lb. Total pull by the bridle rolls should exceed T_1 to insure movement of the strip. Total is equal to 1,047 + 856 + 159 = 2,062 lb, which is 182 lb short.

A fourth roll added to the system—roll 4, shown as dashed lines—will still not do the trick. This addition will increase the wrap on roll #3 to 240° and increase the pull of roll #3 to 244 lb (from 159 lb). The fourth roll itself will add about 70 lb, depending on the degree of wrap as determined by idler #5, but the net gain is too small to warrant the increased cost and bulk.

The solution may call for adding a pinch roll if its squeezing action is not objectionable. In this problem, an additional 500 lb of pulling power would make the unit adequate for its task. Using the equation $F = P/\mu$, then $F = 500/0.3 = 1666$ lb.

The pinch roll should be located beyond roll #3. It need not be driven by an outside power source.

Total hp for the system is: $\frac{2{,}244 \times 400}{33{,}000} = 27.2$

SYMBOLS

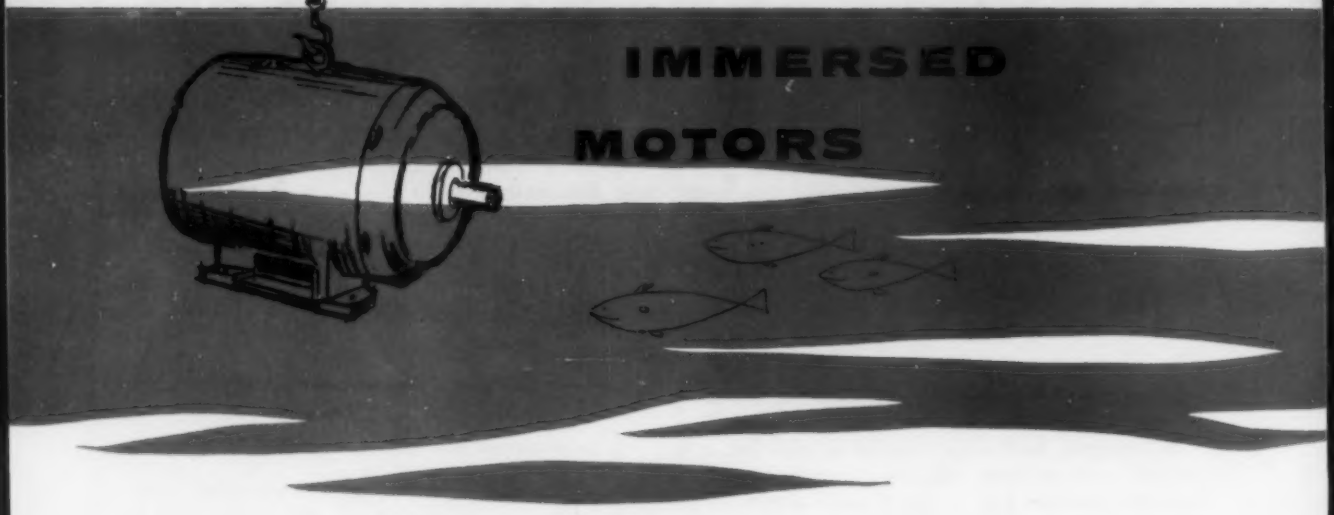
e—logarithmic base = 2.718	t—thickness of material, in.
F—squeeze force exerted by rolls, lb	V—line speed, ft/sec
P—drag force on strip, lb	W—material width, in.
R—roll radius plus $\frac{1}{2}t$, in.	θ—contact angle, deg
S—allowable stress, psi	μ—coefficient of friction
T—tension, lb	

DRAG POWER

Horsepower requirements for the drag system in Fig. 5 are computed the same way as for pulling, except that here you start with T_1 and then work backwards. Thus $T_2 = 673$ lb and $T_3 = 202$ lb. To obtain the initial tension of 202 lb, it is best to install a pinch roll with $F = 202/0.3 = 673$ lb. The air or hydraulic cylinder must then be powerful enough to provide a squeeze force of 673 lb and also lift the weight of the roll and supporting members. ■

AN UNDERWATER MOTOR **can be canned, potted or given sealed-in fluid—and now we have some of completely open construction. Take your pick of these . . .**

IMMERSED MOTORS



STAFF REPORT

FRANKLIN D. YEAPLE JR
Associate Editor

Interest in submersible motors has been sparked by the coming of the all-wet type. It is a motor completely open—the fluid in which it is immersed flows freely through windings, airgap and bearings. Like other submersibles, it is not limited to underwater applications. Any place the driven load (such as boiler feed pump or oil sump pump) is submerged, then the motor might well be too. The other submersible types, however, vary in how much wetness they can take:

Wet only around rotor and bearings. Two examples are "canned" and "potted" motors. Canned type has hermetically sealed stator . . . with increased electrical losses because of metal in airgap. Potted-stator type has normal airgap but poorer heat-dissipating ability because of epoxy or other encapsulating material around windings.

Wet throughout, but serviceable only with a selected fluid such as fresh water or oil. Motor is filled beforehand, then sealed. Limitation: in service, the external fluid may eventually leak in and dilute the sealed fluid.

Some variations are possible. For example, Allis-Chalmers and General Electric each offer open-type motors with silicone windings (Class B insulation) resistant to water and oil, but bearings are lubricated separately with grease or oil. Furthermore, in a lengthy motor shutdown the fluid of immersion may temporarily affect silicone insulation: oil may cause slight swelling; moisture lowers electrical resistance, though not enough to cause breakdown. Running the motor provides enough heat to dry out windings to original condition.

ADVANTAGES OF OPEN-TYPE

Completely open construction is newest of the four types. General Electric and Byron-Jackson have already sold such "wet" motors. The GE version, discussed here, is the only one whose windings are designed and manufactured in the US. It is available in one style: ac, squirrel-cage, single-speed, polyphase, induction, from 100 to 1000 hp. The Navy has already announced a special version for a motorized rudder. Another possibility: main propulsion drives on small or medium boats.

Windings in the GE stator are sealed in special insulation of the irradiated-polyethylene type (essentially NEMA Class A) to completely exclude water from the copper windings. The bearings are made of rubber (for salt water immersion) and graphite (for fresh or boiler water).

Water is throughout the running motor and acts as both coolant and lubricant. The motor cannot be run full-load in dry air because the insulation is not designed to take the heat that results in the winding. Silicone insulation is probably better here and would be recommended.

All electrical parts, including terminals, are sealed and tested before motor is shipped. Long, sealed leads are brought through motor enclosure with special bushings.

Dielectrical breakdown resistance of windings is excellent. Mechanical strength plus abrasion resistance is also designed-in.

Field testing indicates a very long life for the water-lubricated bearings. Loadings are low (for example, 30 psi on thrust at full load).

Motor design here does not otherwise differ radically from that of a standard, open, squirrel-cage motor. Airgaps are the same. Voltage allowed at present is 440 max. Multispeed windings can be selected and part-winding starting is also possible. Conductors are standard design. Both shell-type and complete motors are available. This wet motor is closest to a Design B (NEMA standards) because of similar starting-torque characteristics. It will also meet 80%-voltage starting requirements.

IMPROVEMENT COMING?

Broadening the applications of open-winding motors is entirely possible. New silicones with special glass-fabric supporting materials are already past development stage at GE; they promise less oil-swelling and more toughness. Dupont's Teflon is a possibility for a tough, high-temperature (Class H) insulation, but would be higher cost—and is not recommended for nuclear applications.

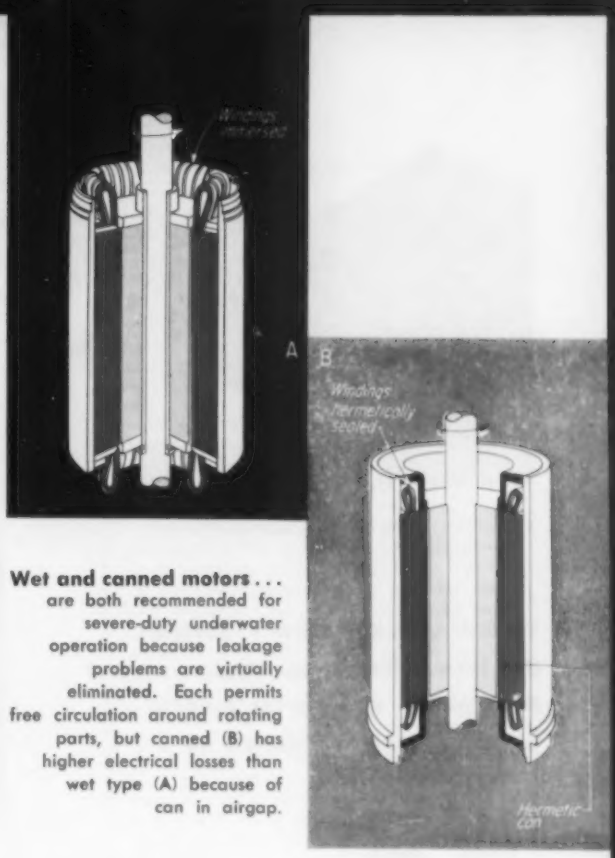
When a "universal" ideal insulation is discovered, then open-type motors may replace weatherproof, ducted, and conventional submerged motors, as well as those for contaminated atmospheres. Periodic hosing down would be enough to keep the windings clean.

OTHER SUBMERGED TYPES

A direct comparison of canned, potted, and sealed motors with the all-wet type is possible by considering two typical loads they can drive:

High-pressure boiler feed pumps can use dry motors but pump-shaft seals are required. If this is not objectionable (because of leakage or seal replacement) a standard motor-pump is good. Otherwise, an all-wet or a canned motor should be enclosed with the pump. The wet motor, having conventional airgap and open construction, will be about 90% efficient. This is 10% more than with the equivalent canned motor, but 2% less efficient (because of increased windage) than with conventional in-air motors. Both canned and wet motors will withstand up to 2900 psi whereas mechanical seals are limited to 2600 psi. However, the boiler feed water may be too warm for effective cooling of a wet motor, so a thermal seal that limits fluid interchange is usually placed around shaft between pump and motor. A simple impeller pump in motor housing will keep motor water circulating through bearings, windings and built-in heat exchanger.

Sump pumps, whether for oil or water, gain versatility if motor can run completely submerged in the fluid. Coupling shafts can be short, eliminating some balance and wear problems inherent in long drive-shafts. Potted, canned or all-wet motors can usually be used. Oil- or water-filled sealed motors are also satisfactory, but some interchange of fluids may occur eventually.



Wet and canned motors . . . are both recommended for severe-duty underwater operation because leakage problems are virtually eliminated. Each permits free circulation around rotating parts, but canned (B) has higher electrical losses than wet type (A) because of can in airgap.

EDITOR'S NOTE: Recent news developments giving background for this article were covered in: "Submarine Motor," Aug 25, p 15—Navy announces new "wet" type motor for underwater steering control; "Motor Designed for Immersed Operation," Sept 1, p 55—availability of this type motor for industrial applications.

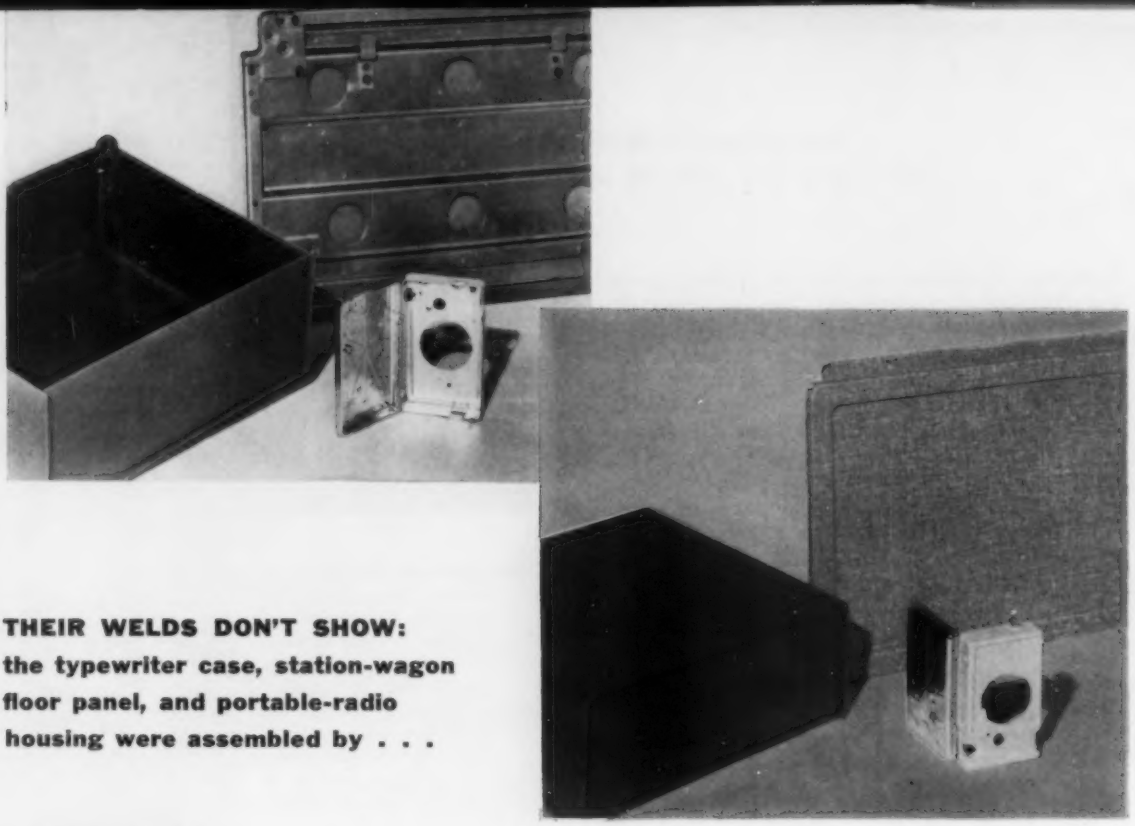
Other submerged motors introduced here include:

"Immersed Motor Stays Dry," Apr 14 '58, p 64—1/20-hp tubless-washer ac motor, with potted stator; "Pump Motor Uses Gasoline as Lubricant and Coolant," Mar '56, p 155—how carbon sleeve bearings and liquid-cooled, potted stator enable ac motor to run in gasoline; "Hermetically Sealed Pump-motor Units Will Handle Any Fluid," June '53, p 216—design details of canned ac motor with pressure-lubricated hydrostatic bearings.

Good electrical insulation is one secret of submerged and other difficult ambient operations:

"Silicone Rubber Resists Oil," Aug 18 '58, p 23, describes GE's nitrile silicone that combines nitrile rubber's oil resistance with silicone's high-temperature range (—100 to 500 F); "Properties and Applications of Silicone Rubber," Mid-Oct '57, p C22, discusses properties (tensile strength, moisture resistance, dielectric strength) for both high and low temperatures; "New Materials by Irradiation," Apr '57, p 167, includes the unusual surface-strength properties of irradiated polyethylene.

Other motor articles dealing with working-atmospheres: "How to Select Motors for Contaminated Atmospheres," Oct 14 '57, p 106, in which tables help pick proper enclosure; and "Controlling Temperature Rise in Induction Motor Drives," Jan '57, p 167, gives tips to limit unnecessary heating of windings caused by improper choice of motor for job.



THEIR WELDS DON'T SHOW: the typewriter case, station-wagon floor panel, and portable-radio housing were assembled by . . .

MAGNETIC-FORCE

the new joining method for vinyl-clad steel

FORD R. PARK, *Associate Editor*

It worked with tricky electrical contact metals and now Precision Welder and Flexopress Corp has adapted the method to solve another problem. This article gives first data on weld strengths, welding arrangements, and ways to escape trouble.

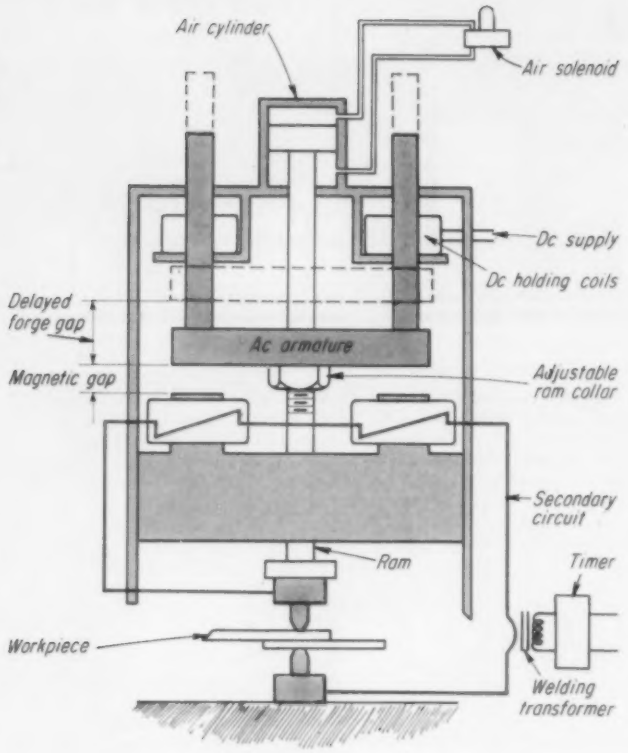
Can't there be a better way to join vinyl-clad steel? The problem has plagued designers ever since this versatile prefinished material was introduced five years ago. The only way, until recently, was mechanical . . . the vinyl-coated parts were assembled with rivets, screws, lock seams, and welded studs–sometimes with adhesives. But none of these methods were ideally suited to the fast production needed with this premium-price material.

A new approach has been worked out by Precision Welder and Flexopress Corp., of Cincinnati. It adapted magnetic-force welding to do the job. The steel is joined with a strong resistance weld, and there is no harm to the coating of vinyl.

The main trick was discovering how to weld fast enough to avoid unsightly damage to the nearby coating, which softens and blisters at about 300 F. Extremely short weld time–in the order of 1½ milliseconds–requires high voltage to release enough energy in the weld zone for melting the steel so the two members will fuse. Also, the welding force must build up fast enough to forge the attachment material to the coated steel at the instant the steel is molten. Moreover, the current must be brought indirectly to the weld zone through the uncoated side of the metal because vinyl is an excellent electrical insulator.

Meeting these conditions calls for projection-welding techniques. A dimple is punched in the underneath piece to give a concentration point for the weld current, thus avoiding shunting between the sheets that would rob the weld zone of current. But with vinyl-clad steel, pressure must be just right–low enough to keep contact resistance high and thus generate enough heat for welding; high enough to prevent arcing between electrode and steel and to assure followup forging action when the projecting dimple collapses. Conventional force-system resistance welders, even when adapted with spring-loaded electrode holders, do not give enough control over welding force: if springs are stiff enough for fast forging

(Text continued on page 85)



Magnetic-force Welding—How It Works

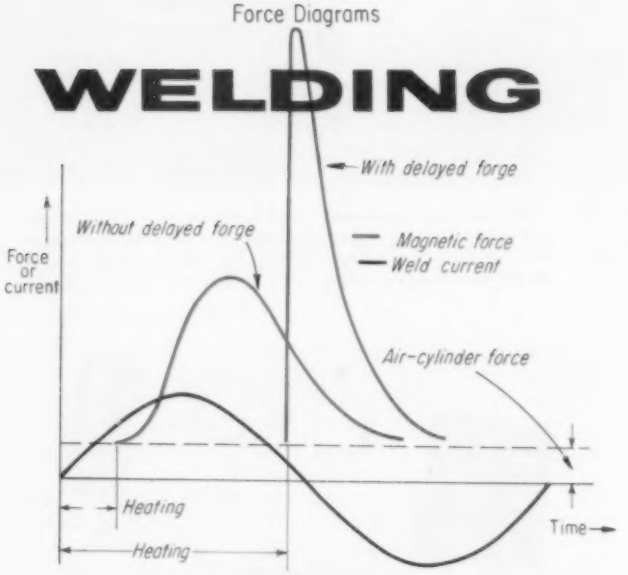
Key to precision resistance welding is close synchronization of pressure and application of heat. An electro-magnet—energized and timed by welding current and its controls—creates the force that would otherwise come from hydraulic or pneumatic cylinder. This controls pressure application to a fraction of a cycle and permits lower initial electrode holding force. Two advantages result: more heat from the current because of the higher resistance that goes with light electrode pressure; welding force is brought in when the weld zone is most fluid.

For high-conductivity metals two methods are shown in the drawing at left. In conventional magnetic-force welding, armature sits on the collar (lower position) as initial pressure is applied by air cylinder. Final force on the weld is controlled by the magnetic gap set by the ram collar. Some combinations of material need a longer heating period before welding. For this, a delay magnet, dc-powered, is mounted above the armature and opposes the welding-force magnet, holding the armature above the collar (upper position) at a pre-determined "delayed forge" gap. As weld current begins to flow, the magnetic flux in the force magnet increases, overcoming the delay magnet to deliver the forging blow.

The wave-form curves at left compare the two force systems in relation to input of current. Higher values with the delayed-forge system result from kinetic energy transfer as the armature traverses the forge gap.

For welding vinyl-clad steel, where conductivity is low, delayed forge is undesirable since the metal heats faster. Here, synchronous controls actuate the force current independently of weld current. Thus, force can be initiated before weld current for the desired timing.

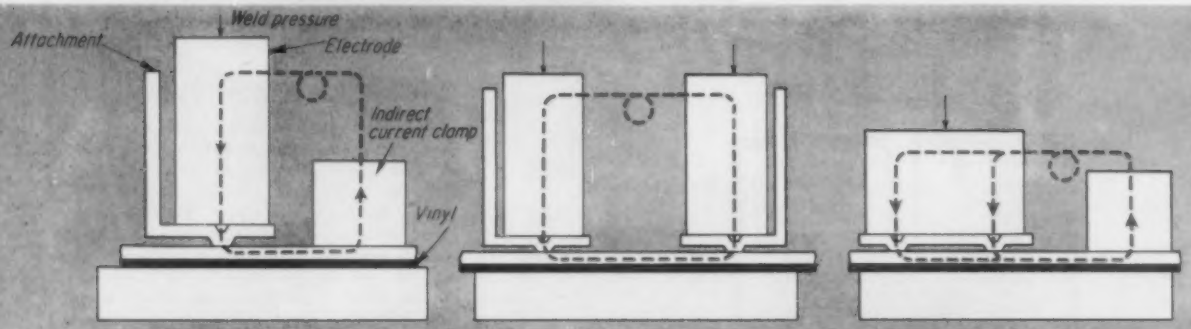
Force Diagrams



Strength Comparison—Projection-welding Methods for Vinyl-coated Steel
(tensile shear & pullout in pounds)

Strap Thickness, in.		Magnetic-force Welder		Press Welder		Capacitor-discharge Welder	
Coated	Uncoated	Shear	Pullout	Shear	Pullout	Shear	Pullout
0.027	0.019	442	...	310	142	210	130
0.035	0.040	750	460	220	198	343	...
0.050	0.040	960	510	348	295	270	...
0.062	0.080	1350	1065	830	563	450	...

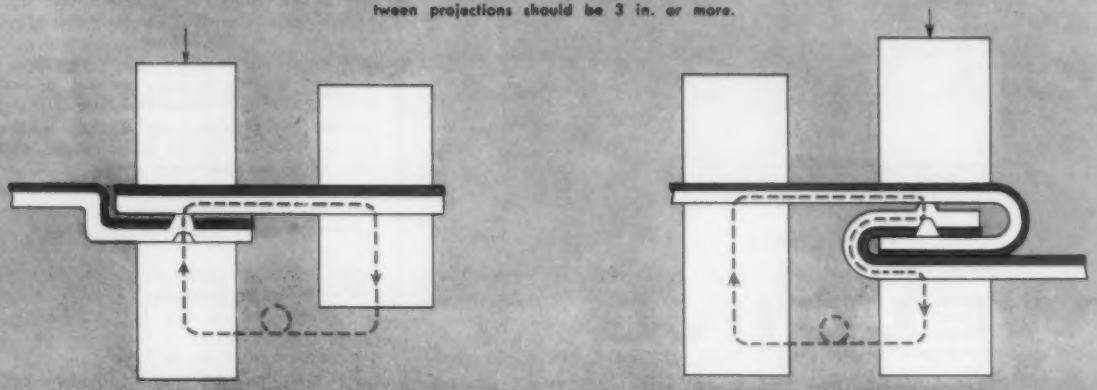
FIVE SETUPS THAT FOCUS CURRENT AT THE WELD



Indirect welding — one piece coated. Here, vinyl-coated piece is supported, bare side up, on cooled block of copper or steel; weld current enters uncoated material through an electrode which also supplies followup pressure and forging blow. Current clamp completes circuit to weld transformer.

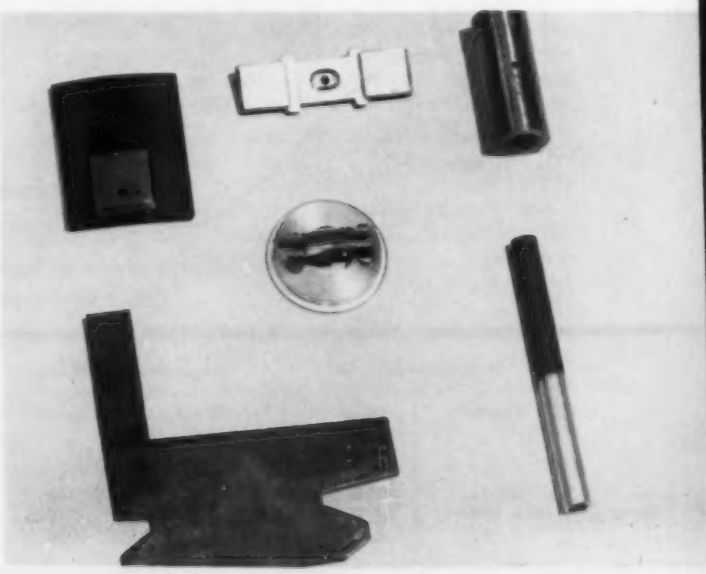
Series welding — one piece coated. Electrodes contact each of two uncoated attachments, and deliver followup and forging blows. Series setup can also make two adjacent welds when they are part of a single attachment. Here, uncoated piece should be as thin as or thinner than coated piece to reduce shunting; distance between projections should be 3 in. or more.

Parallel welding — one piece coated. A single electrode spans both weld points. Current divides and flows through both projections, with current clamp completing circuit. Clamp location and shape determine uniformity of current division.



Indirect welding — both pieces coated. The projection, formed through vinyl coating on one piece, has its tip brushed off to permit electrical contact. Offset lap joint hides uncoated edge. Stripping the vinyl in the projection area instead of brushing is more efficient, but also more expensive because of extra operation.

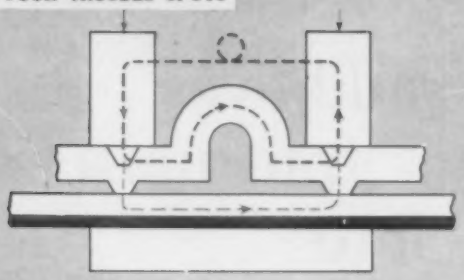
Indirect welding — both pieces coated. Folded seam joint is a common method for hiding exposed edges, but projection weld locks the joint for added strength. Bottom sheet can be offset flush to the top sheet to further disguise joint. Method also works on corners.



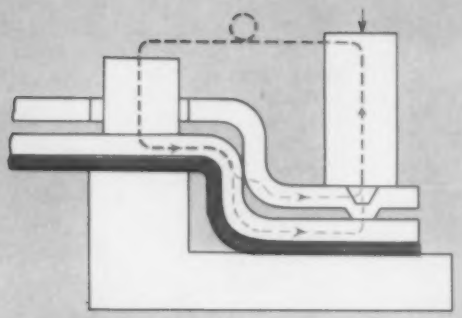
These problem parts . . .

don't use vinyl-clad steel but also show versatility of magnetic-force welding. At top, from left: mild-steel balance weight on malleable-iron brakedrum—requires large-area weld with shallow heat penetration to protect braking surface; copper circuit-breaker arm calls for full-area weld to dissimilar contact metal (here, silver cadmium oxide); automotive valve-lifter has free-machining steel body and hardenable cast iron cap—requires leakproof weld. Center: earphone magnet has pole faces positioned within 0.0002 in. of face of aluminum base by four welds at studs. Bottom: All-copper commutator assembly with riser welded to bar saves material, gives greater strength over brazing because annealing affect is localized; aluminum-copper tubing joint requires full-area leakproof weld.

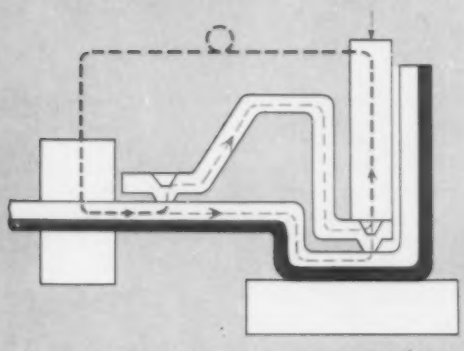
FOUR TROUBLE SPOTS



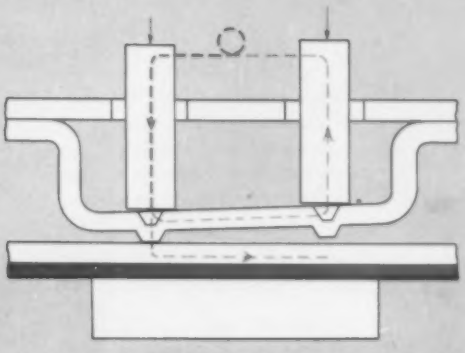
Attachment too heavy. This starves the projection of welding current by shunting flow through attachment, resulting in weak or incomplete weld. **Remedy:** keep attachment as thin as or thinner than vinyl-clad part to restrict shunt current.



Poor fit-up. Weld current entering the vinyl-clad steel is shunted to the attachment at first contact point, preventing full fusion at the weld zone. **Remedy:** check fit-up before starting a production run and correct prior forming steps or part design accordingly.



Current clamp too remote. High voltage drop from clamp to projection starves weld zone and increases likelihood of shunt loss at intermediate points. **Remedy:** punch access hole in attachment for closer clamping, or increase initial voltage if redesign is not possible.



Attachment too stiff. Built-up attachment makes assembly inflexible, aggravates already poor fit-up. Unbalanced electrode loads required for contact then give nonuniform welds, cause electrode wear. **Remedy:** separate the attachment from secondary reinforcement unless perfect fit can be assured.

action they reduce local heating by upsetting the projection too early in the welding cycle.

Dual Force Does It

This problem was solved with magnetic-force welding. It provides a dual force system: an air cylinder for light initial holding force, and an electromagnet for the precisely timed welding force. Magnetic-force welding was originally developed for joining electrical contact materials which require local heating and careful control of weld force because of their narrow plastic range. For such materials, welding force lags behind the heating current. With vinyl-clad steel, however, weld time is so short that this lag—so desirable in welding contact metals—is enough to prevent the followup force from coming in before the weld zone starts to cool. So the procedure is reversed: the circuit is altered by introducing separate transformers and controls: energizing the magnet transformer before the weld transformer so the necessary force is present, and strong enough, when the projection reaches melting temperature.

The result is stronger welds than with conventional resistance-welding techniques, as shown by the shear and pullout comparison in the table on page 83. These strengths can be increased about 25% by coating the bare side of the vinyl-clad steel with an aluminized epoxy paint—a step that also protects against corrosion, though ductility drops. Weld penetration into the clad sheet is good—up to 20% measured on production welds.

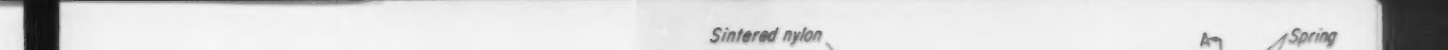
Beyond the usual conditions required by conventional resistance welding, design of parts should be based on these two keys to success with magnet-force welding:

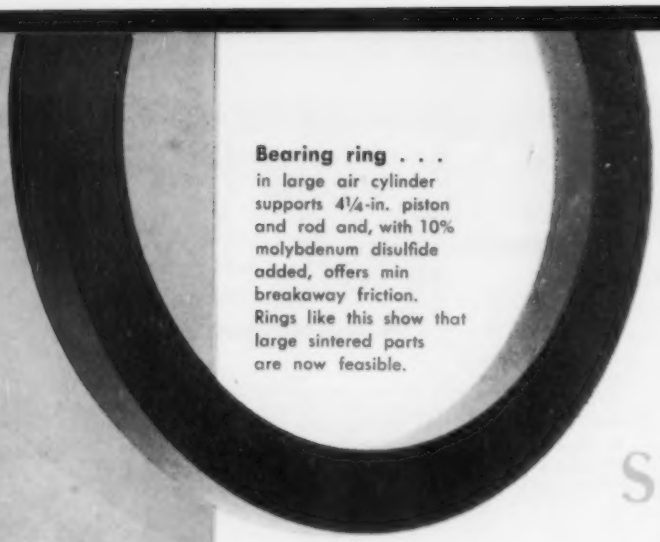
Indirect welding. Design must permit entry of weld current into the uncoated side of the vinyl-clad steel sheet; therefore good accessibility to the backside is a primary objective. Different joint types require suitable setups for entry of current.

Light initial electrode pressure. Electrodes cannot be called on to be forming tools—don't expect them to correct poor fit-up, excessive stiffness, or inadequate current flow caused by the wrong choice of attachment-material thickness.

REPRINT of this article can be obtained for your reference file by checking E42 on one of the Reader Service cards bound in this issue. For further reprints available see "Current Reprints" listing in this issue on page 153.

EDITOR'S NOTE: Further information on how to design with prefinished metals appears in the following articles: "Sandwich Panel Adhesives," May 26 '58, p 56; "Textured Steel," Mar 17 '58, p 73; "Prepainted Steel, Dec 9 '57, p 99; and "Vinyl Laminate," July '56, p 167.

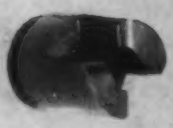




Bearing ring . . .
in large air cylinder supports 4¼-in. piston and rod and, with 10% molybdenum disulfide added, offers min breakaway friction. Rings like this show that large sintered parts are now feasible.

additives put muscle into SINTERED NYLON PARTS

Lightweight roller . . .
for machine tape-perforator replaces spool and bearing assembly, contains 10% molybdenum disulfide for lubrication-free service at low friction coefficient.



Clutch-half . . .
couples motor to oil burner pump, replaced rubber-coated bronze forging through lower cost, better dimensional stability and clamping capacity, and self-lubrication.

Piston . . .
in air-operated switch has 25% graphite to control dimensional change from absorbed moisture and lubricate spherical seat. Machined groove for rubber seal ring cannot be sintered.

Slide Ring . . .
in power-steering hydraulic system has wall thickness within ±.0005 in., low friction coefficient, and sufficient ductility in split ring form for snap assembly.

Rubbing block . . .
for high-speed ignition system offers wear and impact resistance, self-lubrication, and close dimensional control without machining, contains 10% molybdenum disulfide.

L. W. ALEXANDER, *General Manager, Halex Corp, Detroit*

Nylon has been solving its troubles as a material for such mechanical parts as cams, bearings and bushings. It went part way when it borrowed the techniques of powder metallurgy—sintered nylon overcame plastic flow, a bugaboo of nylon in the molded form. Though this flow improved wear resistance, it reduced the ability of nylons to bear compressive loads.

Now sintered nylons can be fortified several ways, with graphite or molybdenum disulfide additives. Result is stronger parts with moisture resistance that improves dimension control; yet there is no loss of molded nylon's low coefficient of friction and quietness of operation. Until the additives came along the sintered nylons were limited to 200-psi loads at low speeds. Now they can take higher loads without deforming, and their self-lubricating properties allow higher speeds.

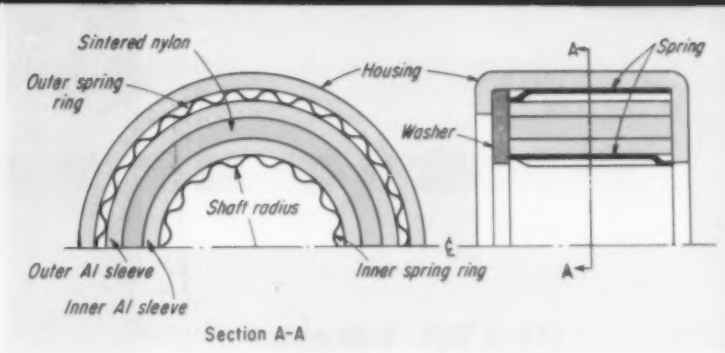
Thanks to closer tolerances and a wider choice of sintered grades, these materials show promise for a widening variety of mechanical parts. They may replace small diecastings, powdered-metal parts or injection-molded nylon parts—with cost-savings in materials and processing time. Here is the updated story on recent formulations and their design characteristics.

Basic Technique

The nylon powder or mixture is cold-pressed in dies similar in shape to those of powder metallurgy. The compact is then sintered in a non-oxidizing atmosphere to give the compact its useful mechanical strength. Temperature is kept just below melting point of the nylon—to keep shrinkage uniform and prevent internal stresses that would cause subsequent dimenisonal change.

New Compositions

The basic grades of sintered nylon are grade 66, which uses type-66 nylon powder, and grade 64, which combines types 66 and 6. In grade 64 the powder is more finely divided, giving improved impact strength over grade 66. The new compositions are made by adding 20 to 60% graphite to each of the basic grades. For very low friction coefficients, and extra impact



Section A-A

New sleeve-bearing design . . .

keeps clearances constant as rising temperature expands sintered nylon. Key elements are inner and outer corrugated spring rings—flexible enough to give under high, radial, thermal-expansion forces; stiff enough to resist lower operational bearing loads. Sintered-nylon sleeve is a press fit in protective outer aluminum sleeve. Inner spring ring supports inner aluminum sleeve, which slides against the nylon sleeve. When shaft is smooth enough, nylon bearing can ride directly on the shaft, eliminating need for two parts. Design is also adaptable to other bearing materials.

Bearing Materials Compared

Property	Sintered Nylons[a]	Molded Nylons	Sintered Bronzes
Flexure strength psi × 1000	4.6–9.9	8.0–13.8	18–25
Elongation, %	1.0–2.5	60–300	1.0–2.5
Compressive strength, psi × 1000	9.5–19.8	13–17	34–80
Water absorption (24 hr), %	0.2–1.2[b]	1.5	n.a.
Bushing strength constant *K*, psi × 1000	7.9–16.2[c]	15–21	22.5

[a] With graphite, molybdenum disulfide or ceramic additives
[b] Reduced 40% by impregnating with suitable oil
[c] Same as ASTM B 202-55T for metal powder bearings. Where $K = p(d - t)/Lt^2$; p = radial crushing load (lb); d = diameter (in.); t = wall thickness (in.); L = bushing length (in.)

resistance, 10% molybdenum disulfide is added in place of the graphite. When wear must be minimized, grade 66 with 45% zirconium silicate is used. Other combinations are possible because the process lends itself to composition adjustment over a wide range.

In general, adding graphite lowers the rate of moisture absorption, and increases flexural strength at the expense of ductility and impact resistance. High graphite content also lowers dielectric strength and resistivity.

Closer Tolerances

Sintered dimensions and tolerances depend on size and composition. Graphite stabilizes the dimensions and gives more accurate parts. Grades with high graphite can now be held to these tighter dimensions:

Diameter, in.	Tolerance, in.
up to 0.75	±0.0007
0.75 to 1.5	±0.001
1.5 to 2.5	±0.002

Tolerance on thickness is 2 to 3 times radial tolerance. These extremes can be held for all grades but add expense when graphite content drops below 50%. Most economical tolerances are about twice those shown.

For machining parts to final dimensions, stock must be removed by cutting. Sizing by burnishing will not give accurate sizes because the resilient materials will spring back. However, its greater resistance to flow makes it more machinable than other thermoplastics.

Mechanical Properties

Properties given in the accompanying table should be used with discretion. Most of the data were obtained from standard ASTM tests designed for the more ductile molded plastics. But sintered nylons, especially those with the higher additives, are somewhat brittle. They do not give consistent test results, particularly in pure tension, and their properties require some interpretation for correct design. One example: for tensile calculations, the flexure strength is more valid than the tensile strength—as in cast-iron design.

How to Apply

Design with these sintered nylons, while unlike that for either powdered metal or molded nylons, in many ways bridges the gap between the two. For example: while molded nylons can only be used under low static loads up to 200 psi without distortion, sintered nylons withstand higher loads without extruding. But even they should not be used with loads above 1000 psi.

For bearings, clearances must be similar to those of molded nylons—somewhat greater than for metals, to allow for the high thermal expansion of plastics. But the grades containing higher amounts of graphite have an expansion rate only ½ of the pure-nylon sintered grade; so freezing and fusing from insufficient clearance is rare. Best way to get both good alignment and low wear is to back up a sintered nylon bearing in a way, illustrated above, that will not restrict thermal expansion on the outer diameter.

Fringe Benefits

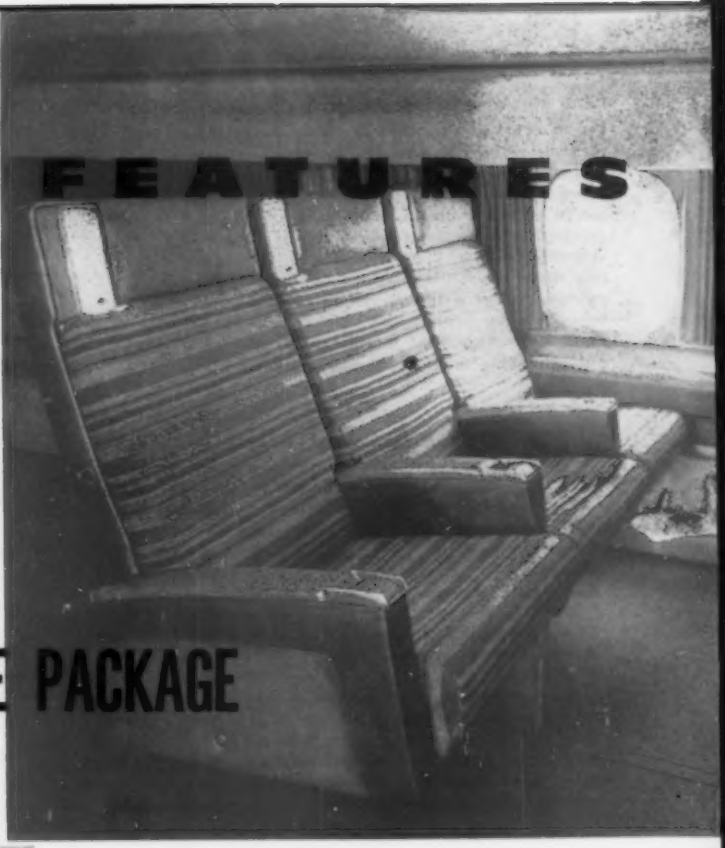
Sintered nylons offer secondary advantages too. For example, on steel shafts, sintered bearings allow wider tolerances without increasing wear. Also, a phosphate coating on cold-rolled steel bar is often sufficient with sintered nylon—where metal or metal-powder bearings would call for finish-grinding the shaft.

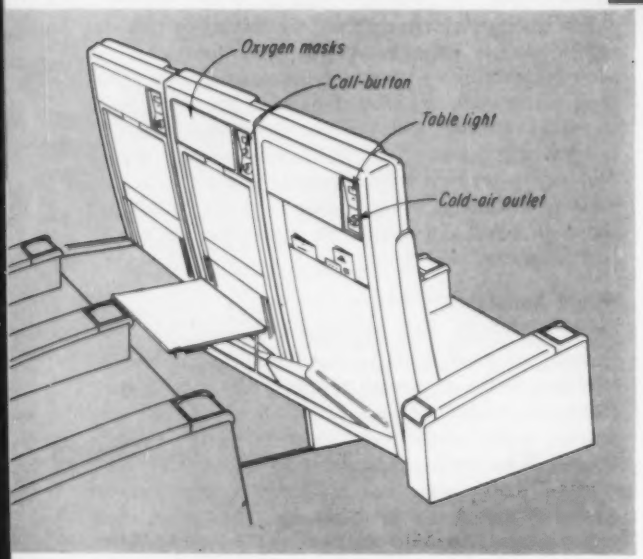
Metal shafts, when not revolving, squeeze out the oil from between shaft and bearings. And when moisture is present, dissimilar metals form a galvanic cell that starts corrosion—these corrosion products, however minute, aggravate wear on both the bearings and shaft. Sintered nylons, on the other hand, do not form galvanic couples; and the porous structure, continually wet with oil, lowers wear of the nylon and the mating metal parts.

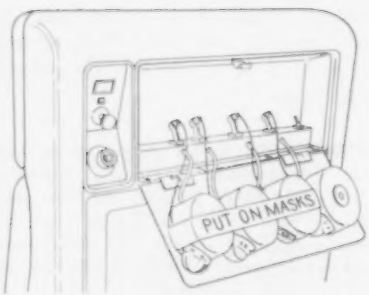
EDITOR'S NOTE: Further information on nylon for mechanical parts: "Which Plastic for Abrasion Resistance," Mar 31 '58, p 105, gives handy selection chart for elastomers and rigid plastics. "New Nylon from France," Dec 23 '57, p 76, describes a polymide with low rate of moisture absorption. "Sintered Nylon Plastics," Nov '54, p 150, tells how they are made; gives properties, limitations.

DESIGN FEATURES

SEATS LOAD PASSENGERS INTO SURPRISE PACKAGE







When seen from front . . .
simplicity of seats is misleading. Looking at them from the rear reveals they are actually a complex package into which servicing facilities are fed. They contain all utilities, which were removed from cabin's overhead and run in duct along sidewall below windows.

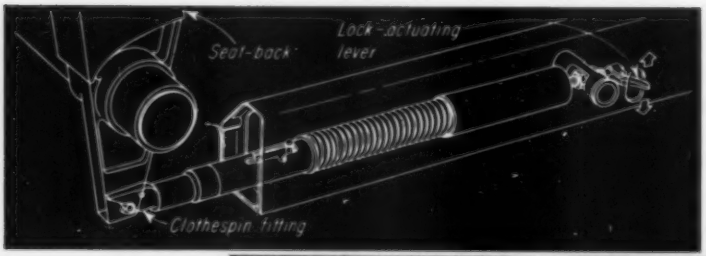
Fluorescent reading lamp is flush-mounted in headrest. Fresnel-type plastic lens beams the light to a 14-by-18-in. pattern located for comfortable reading. Folding utility table is recessed into the back of each seat; table position is not affected by recline angle of supporting seat. Table faces and edges are one-piece laminated fiberglass with foamed plastic core. Recessed into the seat-back directly behind reading lamp is a panel containing table light and its switch, stewardess call-button, and cold-air outlet. Table light provides illumination for dining and writing. When pressed, the call-button rings a chime and turns on a light at the stewardess station, an aisle light in the armrest side panel, and a light in the call button. Cold-air outlet movement is restricted horizontally to an arc of 29°, allowing air to be directed only toward the seat directly behind the outlet.

Passenger oxygen is provided by independent systems —for first-aid during normal operation and for emergency in case of cabin decompression. Four oxygen masks are located in center seat of 3-seat units and three masks are provided in inboard seat of 2-seat units. This provides two extra masks for infants or flight personnel who may be in the aisle during emergency. Should decompression occur above 15,000 ft, barometic activators pressurize oxygen lines and pop the mask-storage doors open. Pulling mask from its spring clip opens mask outlet and delivers oxygen.

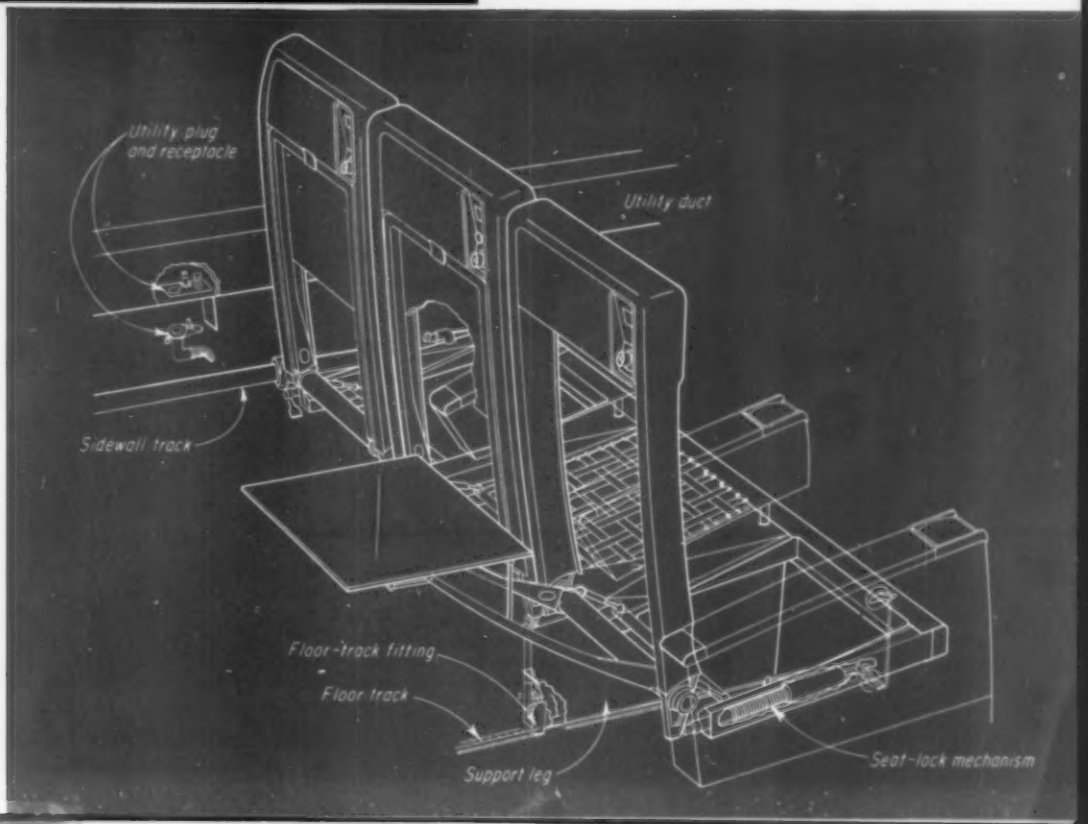
IN NEW PRODUCTS

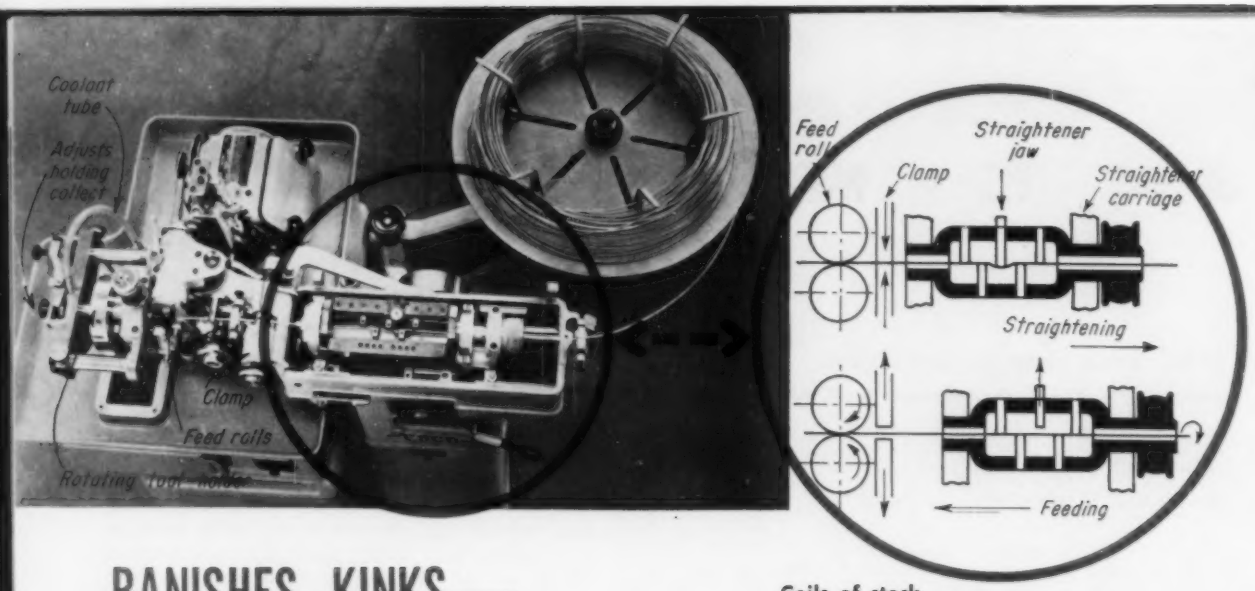
At first glance, these are just airplane seats. But built into their backs are all the service facilities a passenger would want—from oxygen supply to light for dining and reading while in flight.

Object was flexibility needed to keep higher-cost jet aircraft operating at maximum passenger density. Designed for 5- or 6-abreast seating in the DC-8, the "Unit-ized" seat not only simplified servicing the passenger but provides a compact package for storing and handling. This speeds the rearrangement of seating for fluctuating passenger loads, and eliminctes overhead utility installations. The units are produced by Douglas Aircraft Co, Inc, Santa Monica, Calif.



Structural backbone . . .
is 1¾-in. tube to which all fittings and sheet metal are ultimately attached. Design is based on thin-sheetmetal philosophy used in aircraft construction. Aluminum sheet, 0.020 in. for the back and 0.032 in. for the bottom structure, is formed into monocoque and closed torque-box structural members. Under high-impact loads, individual components and the entire structure yield and absorb energy. Under a crash load the forward end of vertical support-leg yields, allowing inboard end of seat to move downward and forward approximately 8 in. A tension strap anchored through the aft floor-attach fittings contains the seat and passengers for static loads in excess of 12 g's. Tracks on the sidewall and in the floor permit fore-and-aft location in 1-in. increments. Quick-acting catches attach seat to sidewall rail and floor track. A single utility plug connects seat to electrical, oxygen and cold-air systems. Corresponding receptacle is located in the utility duct attached to the sidewall. A hydromechanical seat-lock mechanism is housed entirely within the seat bottom. The seat lock is operated by a lever in the armrest to obtain any desired seat angle. A clothespin fitting permits the seat-back to be tilted completely forward for access to emergency exits and for handling ease. Life-vest storage is provided by a pocket attached to bottom of the plastic cushion-suspension straps.





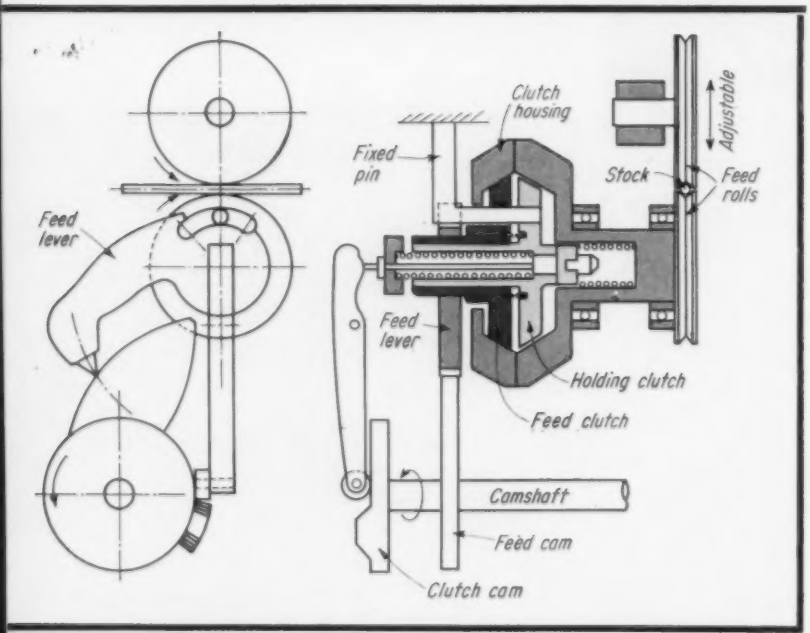
BANISHES KINKS— THEN MACHINES STOCK

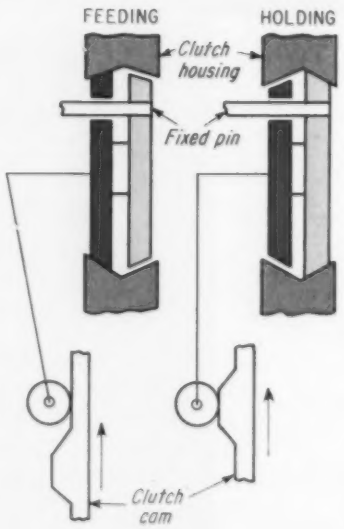
The built-in straightener, plus roller feed, saves time and material. And rotating the tool holder, not the work, lets this automatic screw machine handle unlimited lengths of bar stock.

"Escomatic" is used to machine delicate parts such as axles and pinions for watches and other instruments. Produced by Esco S.A., Les Geneveys-sur-Coffrane, Switz.

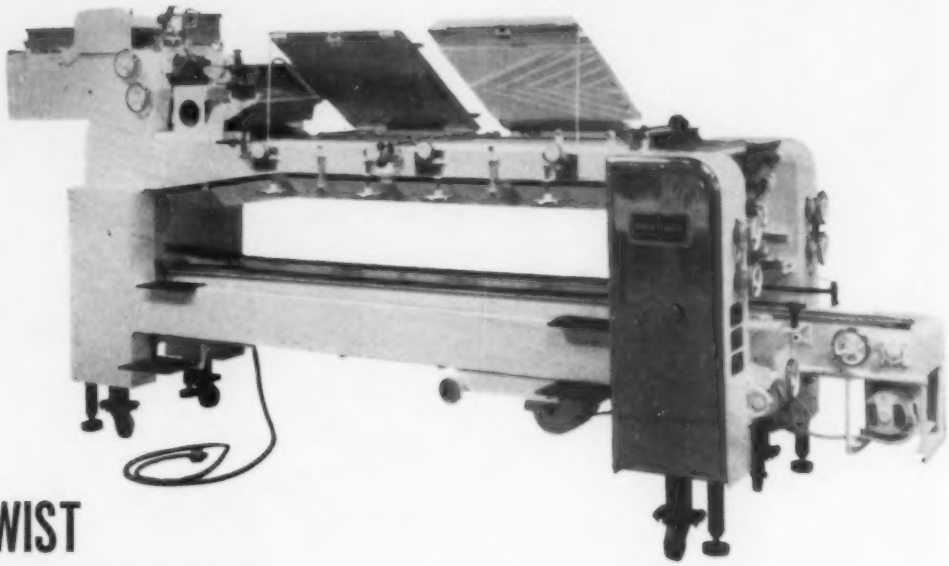
Coils of stock . . .
up to ⅜ in. are straightened immediately before machining. Stock is advanced by feed rolls—no time lost in opening collet, moving headstock, and closing collet—and goes through bushing in rotating tool-holder to holding collet. Coolant is fed through collet to work, then joins chips dropping through hole in table. Finished pieces are pushed through holding collet to box.

All stock movement is controlled by feed rolls. Clamp holds stock while straightener is operating. Clamp and aligning jaw are released during feed stroke and carriage return.





Feed rolls . . .
have dual function: moving stock, and holding it during machining. Cam-operated clutches control all feed-roll movement. Clutch cam, on same shaft as feed cam, positions clutches for the operation selected. Feed cam rotates feed rolls through a clutch and lever. After this clutch is engaged, feed lever is cammed through an arc sufficient to advance required length of stock. At end of this stroke the holding clutch is engaged to hold the stock for machining; the feed clutch is released. When released, feed lever and clutch return to starting position for next stroke. Fixed pin prevents rotation of holding clutch and feed rolls during machining.

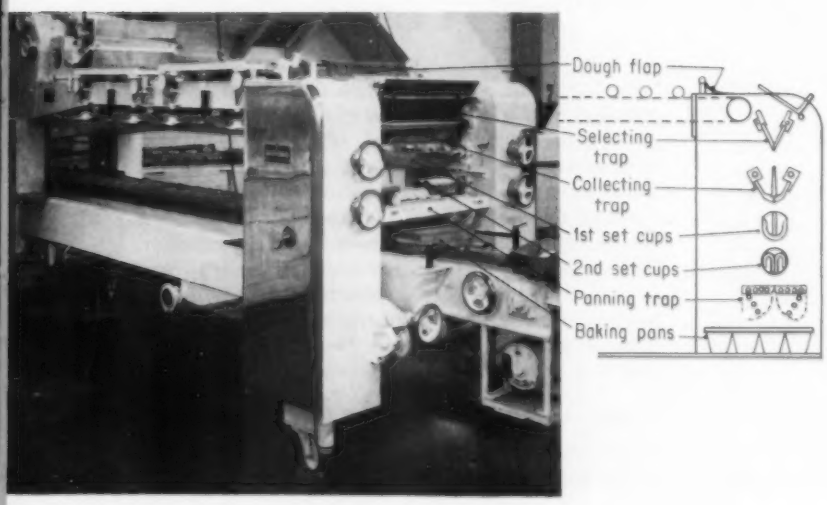


NEW TWIST TO TWISTING TRICK

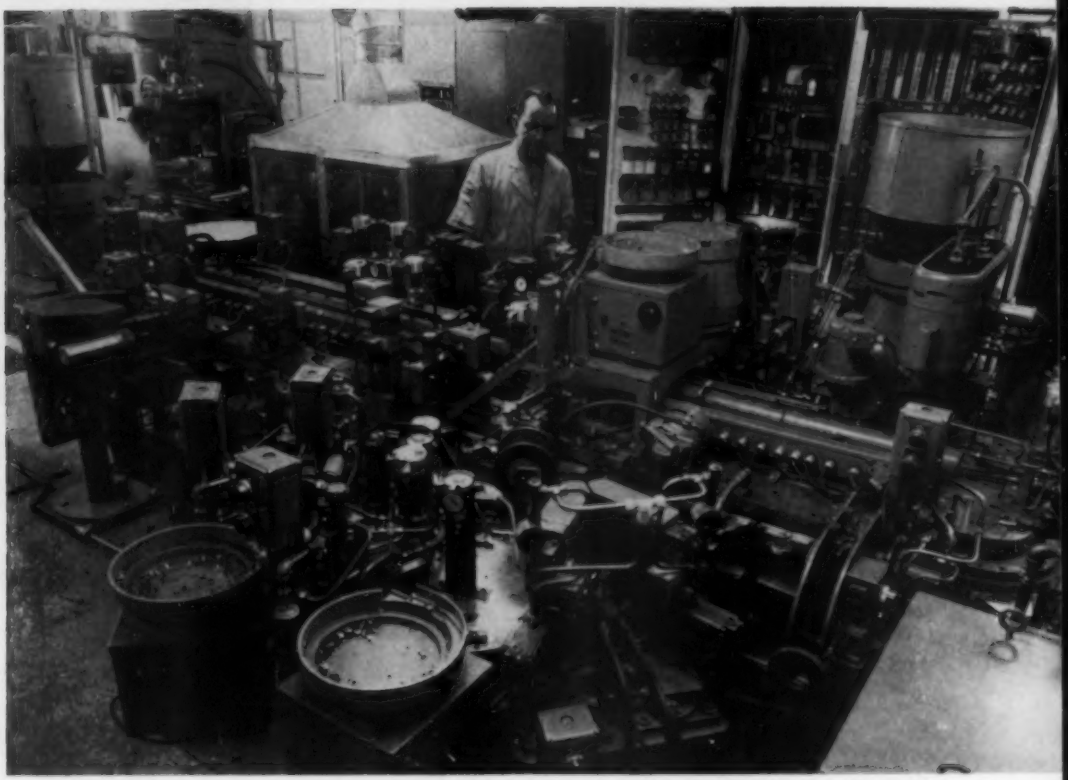
Conveyors here work with mechanical cups to perform a special bakery operation that only human hands were able to do—twist two pieces of dough together. Mechanization gives more uniformity, lower cost, better appearance and finer-textured bread.

Up to 48 twisted loaves of bread per minute can be produced when using this twister-molder-panner to supply the baking oven. Produced by Baker Perkins, Inc, Saginaw, Mich.

Feed-in conveyor . . . receives pieces of bread dough. These are then flattened, dusted with flour, curled and delivered to molding belt. Here two pressure boards seal and extend dough to proper length. As each piece of dough leaves the molding conveyor, it trips a flap and drops into selecting trap. This trap opens every time the dough flap trips, depositing successive pieces into pockets of the collecting trap—from here, dough is released in pairs into the first set of troughlike twisting-cups. The cups are mounted so they rest on their side, face to face; in them, the dough pieces lie alongside each other.



The twisting begins . . . when first pair of cups rotate 180° in opposite directions. This gives a double twist—with the cups operating on every second opening of the selecting trap. Dough now drops into second set of cups. Rotating an additional 180° in opposite directions, this pair apply the third and fourth twists, then drop the dough into the panning trap. This last trap opens to deposit the fully twisted dough into baking pan on the conveyor beneath.



Many stations . . . mean many problems. This 42-station machine assembles, calibrates a thermostat.

Debugging
—THAT LAST STEP IN DESIGN

Performance of a new machine rarely meets expectations—before it can go to customers, you'll have to clean out the bugs. To keep debugging time and costs within reason, use this precise, step-by-step approach.

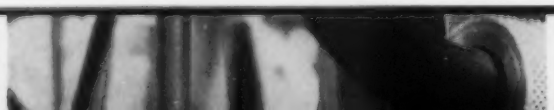
DONALD C. CUMMING, *Westinghouse Electric Corp.*

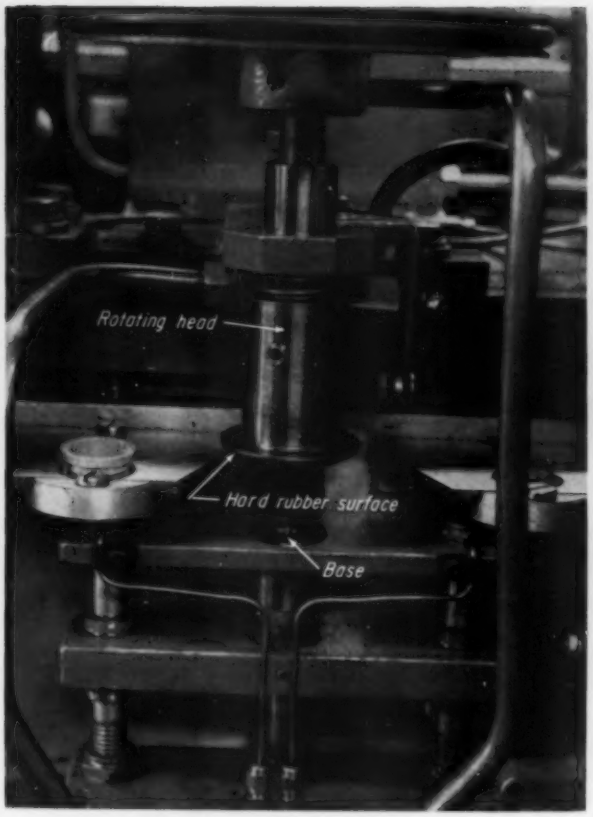
It's what comes after the drafting board that can trip up a mechanism designed to work nicely. The prototype reveals imperfections—friction at some point is more than anticipated . . . fits are too loose or too snug . . . parts get too hot. Whether the troubles come from design errors or out of the blue, the machine must be made to work. Debugging is the unsophisticated word for this fault-finding just ahead of production. It's necessary to some extent in the development stage of any new machine. And it calls for an orderly approach, otherwise debugging costs can equal or exceed cost of the basic equipment and even cancel out savings expected from the machine.

Debugging starts making sense if defined as "Operations to convert a newly created mechanism into an operable, reliable production machine." Three distinct phases are therefore involved: (1) the mechanism must work the way it was designed to work; (2) it must work properly most of the time or within acceptable limits of reliability; (3) it must be a production machine—easily serviced and repaired, safe in operation. Each phase must be considered in order, but without forgetting future steps. A modification that makes the machine operable, but is of doubtful reliability or cumbersome, only postpones the problem for a harder solution in later phases.

I—Does it work?

Check operation of linkages, slides, timing, and pneumatic, hydraulic and electrical equipment. This first





STEP 1—Make it work
Face of the rotating head failed to transmit enough torque to the base in this orienting station. A hard rubber surface solved the problem.

STEP 2—Add reliability
These vibratory feeders fed plates sideways about once every 4000 plates. Restrictors now stop misaligned plates before they jam the mechanism.

step in debugging requires only that the machine successfully complete mechanical or electrical operations for which it was designed. Also, it is the first contact that machine-development personnel have with the mechanism, so they should note deficiencies from a reliability or production standpoint. At conclusion of this phase, the machine should be operable in accordance with design specifications.

II—Does it work reliably?

Suppose the machine works once, will it work twice? If it has run perfectly for one minute, can it continue for hours or days without unusual attention? Probably not. But how many jams and misfeeds can you allow and still have an acceptable production model?

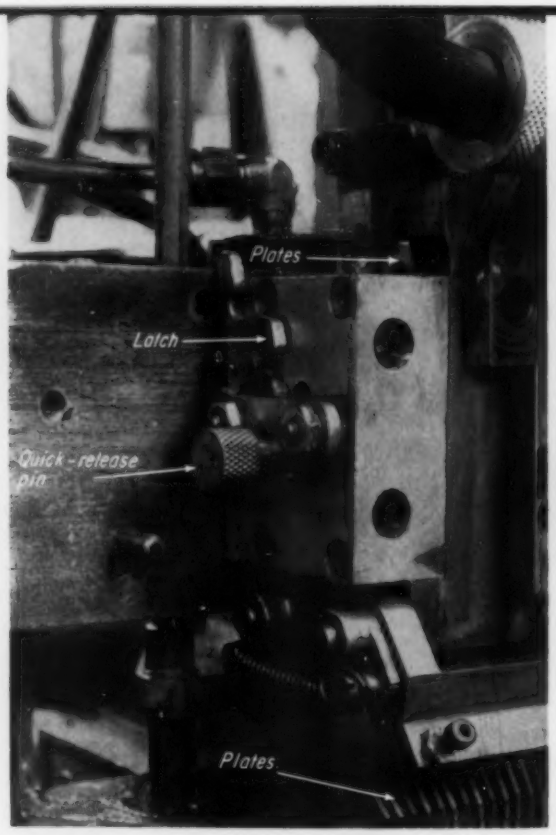
Constructing a machine for automatic assembly of parts involves both mechanism reliability and part reliability. The first means asking, "How often will the machine malfunction when it is fed only acceptable parts?" Acceptable parts are those at both high and low ends of the tolerance range as well as parts with defects allowable in normal interchangeable manufacture, such as burrs, projections, rust. If such defects jam the mechanism, only answer is to set more rigid inspection requirements on them. Relaxing machine tolerances is another way, but with it go risks of lowering reliability by feeding totally unacceptable parts.

The other source of unreliability results from feeding parts that are not acceptable because of piece-to-piece variations caused by die wear, tumbling, machining, plating and other manufacturing processes. A 100% inspection of parts could solve this. Otherwise the machine should be redesigned to reject defectives and pieces of scrap that find their way into the parts bin.

What range of reliability is acceptable? Production rates usually run between 500 and 2000 operations per hour. A single-station machine with 99% reliability would require 5 to 20 stoppages per hour. Even 99.9% reliability is not particularly good—and many machines never reach this level. Multistation machines multiply unreliability. A 5-station machine with each stage giving 99.9% has an over-all reliability of 99.5%. If such a machine performs 1000 operations per hour, it would have to be stopped 5 times every hour. And if each stop took 5 minutes, it would operate only 35 minutes per hour, producing only 650, instead of 1000 parts.

III—Work reliably in actual production?

A machine that operates as designed and within acceptable reliability is still not necessarily a production



STEP 3—Modify for production
A quick-release latch and pin arrangement enables operator to clear this plate-feed escapement in a fraction of the time previously required.

tool. The final debugging step insures that shop personnel can hold it to production standards—without engineers and technicians babying it. Only continued operation under production conditions will indicate the machine's real worth. Here, check to see if it is easily serviced and lubricated, safe to operate and allows convenient, fast tool change.

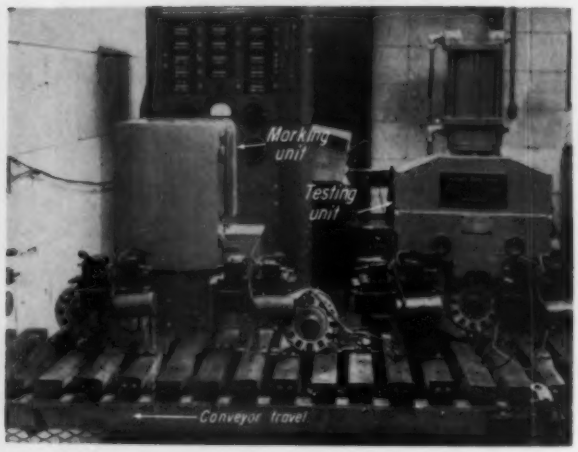
In this phase add production features that may have been neglected earlier. Such elements as loading and storage of parts are important. Stations must be designed for quick clearing because reliability will not be 100% and jams will occur.

Attacking the bugs

Debugging turns out to be a sequence of solving small, individual problems. Though each must be handled separately, all require this approach: "What happened?" . . . "Why did it happen?" . . . "How can it be corrected?"

The first two answers are not always easy; get them before trying the third. If the cycle has gone beyond the trouble spot, the "what" and "why" will have to be found by deduction. Since they usually cannot be deduced, it will frequently be necessary to make the trouble repeat itself. Don't jump to conclusions. An incorrect guess solves nothing and can burden the mechanism with an unnecessary addition or modification.

This method of attack is the same for both single station and multistation machines except that when several stations are involved, there is the additional problem of where to start. In many respects the stations are separate machines and can be taken in turn, particularly in early stages. Later on, when debugging for reliability and production, it is best to start at the last station because this is the station that removes the completed part and is the first station with a clear fixture to work on. After the last station is made operable, start around the machine taking the stations in order. To proceed haphazardly might necessitate rework; changes in either the part or the transfer mechanism at the first station dictate changes in all following stations.



Single-station machine . . .
does not always mean simplicity of a single operation. This automatic motor-tester performs 12 separate tests as motor passes by on conveyor. Unit at left marks motor with test results.

Install adequate safeguards such as limit switches before tackling major stations. If they are neglected, costly collisions can, and will, occur.

The primary tools of mechanism analysis are the five senses. But often mechanism action is too fast and slowing it down obscures what you want to study. Some faults can be revealed by recorders wired to strain gages or accelerometers. High-speed motion picture cameras are also a great help. Many solutions become obvious when pictures of the machine operating at the normal rate are observed in slow motion. Stroboscopic lights, flashing at the right frequency, will also slow or stop the motion of fast-moving parts.

Don't expect to get all the wrinkles ironed out overnight. Where debugging's orderly approach pays is in reducing total time required and number of false starts.

EDITOR'S NOTE: A 16-station machine that can be completely retooled in a few hours is described in "Assembly Machine Engineered for Quick Changeover," Jan '56, p 172.

Full-scale, detailed wooden models will sometimes help avoid design errors before they get to the prototype stage. "Use of Mockups in Design," Oct '56, p 183, tells how they are used.

When the product—and the machine to make it—are designed together, assembly machinery can be both simple and inexpensive. Three case histories are given in "Design for Automatic Production," June 23 '58, p 81.

first in silicones

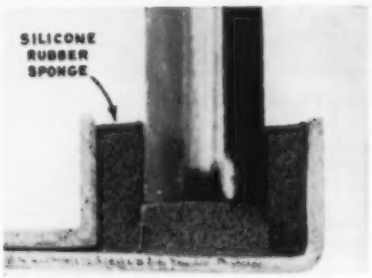
Dow Corning

SILICONE NEWS

for design and development engineers • No. 54

SILICONE RUBBER SPONGE CUSHIONS THERMAL STRESS

Cabs on steel mill cranes work in areas so hot they must be made air-tight and air-conditioned. But hot air on the outside, and cool air on the inside, create such mechanical stress that cab windows crack repeatedly. Replacing the double and triple panes time after time can be extremely annoying and costly. Alliance Machine Company (Alliance, Ohio), manufacturer of crane cabs, eliminated the problem by cushioning the glass in Silastic®, the Dow Corning silicone rubber.



Molded by Garlock Packing Company, the silicone rubber sponge completely cushions and insulates the glass panes from the metal window frame, so they are no longer subject to stress. The Silastic sponge material has proved so effective, Alliance engineers are fast forgetting that the window cracking problem ever existed.

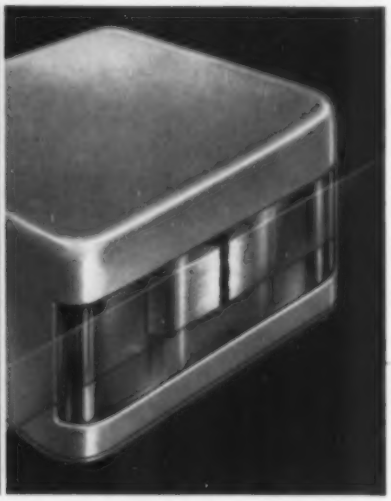
"Throwing in the sponge" solves many excessive heat or cold problems . . . if the sponge is Silastic. Silicone rubber provides the ideal solution to this problem, and many others like it, because it retains its shape, strength and resiliency despite prolonged exposure to temperatures from —130 to 500 F.

Effect of Heat Aging on Flexibility of Silastic and a Heat-Stable Organic Rubber

Temperature	Hours	Flex Life[1]	
		Silastic	Organic
300 F	0	OK	OK
	96	OK	Broke
	1344	OK	——
	6384	OK	——
392 F	0	OK	OK
	19	OK	Broke
	1344	OK	——
	5040	OK	——
480 F	0	OK	OK
	8	OK	Broke
	168	OK	——
	1344	OK	——

[1]As indicated by ability to take an 180 degree bend over 3/8" mandrel without breaking.

No. 550



INCREASE LIFE AND PERFORMANCE LEVEL OF MAGNETIC TAPE RECORDERS

Magnetic tape recorders, once a novelty, now play vital roles in industry and scientific research. But providing adequate lubrication between recording head and tape has always been a problem. The friction generated when tapes lack lubrication produces annoying "wow" or "flutter". The abrasive action also wears away metal, widens the critical quarter-mil gap in the head, and causes frequency to drop as much as a full octave.

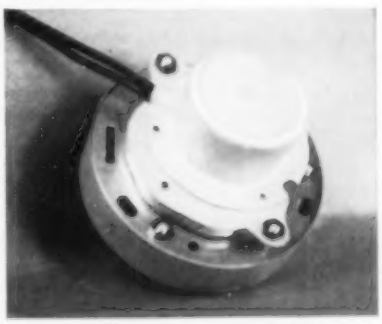
Minnesota Mining has now solved the tape lubrication problem with a Dow Corning silicone fluid. The silicone fluid provides just the right amount of lubricity to allow the tape to glide smoothly over the magnetic head without distorting the sound or generating friction.

Oxidation-resistant, nongumming silicone fluid was chosen because it's a longer lasting tape lubricant than even the best organic oils. To be sure that the lubricant doesn't wear off—like wax lubricants on some tapes—the silicone fluid is mixed directly into the iron oxide coating. The result is lifetime lubrication for Scotch brand magnetic tapes.

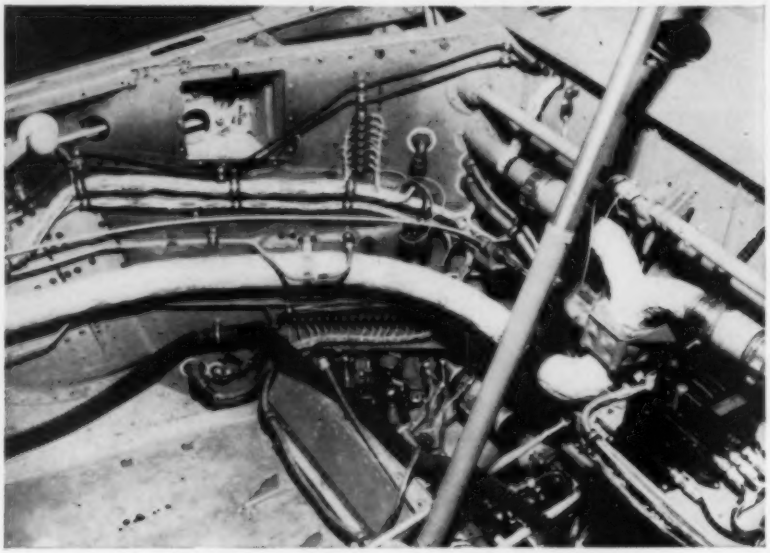
Silicone lubricated Scotch brand magnetic tapes are used for a variety of purposes, including: recording data from rockets, aircraft and meteorological balloons; storing computor data; seismographic survey work; automation; video recordings; commercial music and home recordings. *No. 549*

LIFETIME LUBRICATION FOR 6/1000 CENT EACH

You need only a small amount of silicone fluid to get a big plus in dependable performance. That's the finding of engineers at E. Ingraham Co., Bristol, Conn., who've tested and selected Dow Corning 710 Fluid as a permanent lubricant for washing machine timer-drive mechanisms.



Product improvement research led Ingraham to try Dow Corning 710 Fluid on some of their drive motors and related components in 1950. Finding: the silicone lubricant is so remarkably *(Cont. Pg. 2)*



NEW THERMAL INSULATION USES SILICONE ADHESIVE

To meet the need for a tough, effective thermal insulation for aircraft ductwork, engineers at Cessna Aircraft, Wichita, combined asbestos shorts with heat-stable Dow Corning 271 Adhesive. The resulting mixture has already demonstrated its superior insulating efficiency and serviceability. Approved for use on aluminum air conditioner ducts of USAF T-37A Primary Trainers, a cured coating 0.13 inches thick reduces internal duct temperature of 450 F to 150 F at the insulation surface. A 0.18 inch quartz blanket reduces the same temperature to only 200 F.

The asbestos-silicone mixture can be brushed or sprayed on metallic or plastic surfaces, sets up at room temperature, and can be cured either in service or by oven heat. Combination of the two elements can be varied to produce densities from 30 to 62 pounds per cubic foot.

When oven-cured at 400 F for one hour, a 0.25 inch coating reduces temperatures from 625 F to 250 F. The silicone adhesive is so resistant to high temperatures that cured coatings withstand exposure at 625 F for 100 hours.

Furthermore, the coatings have excellent sound deadening properties and good eye appeal; withstand vibration and abrasion so that no wrappings or top-coatings are necessary; and are insoluble in MIL-L-7808 oil. *No. 551*

LUBRICATION *(Continued)*

resistant to oxidation, moisture and contamination that it will outlast most washing machines. Another finding: silicone lubrication helps keep the timer-drive mechanism operating quietly by providing uniform viscous damping during operation.

Also important: the cost of this long-lasting dependable lubricant is about six thousandths of a cent per unit.

The advantages of silicones over organic oils were so apparent to Ingraham that 710 Fluid was the only lubricant even considered when a subsidiary, E-Town Time Corp., Elizabethtown, Ky., introduced a new line of timer motors in 1955. *No. 552*

new literature and technical data on silicones

Silicones as Dielectrics provides design engineers with a convenient selection guide to the silicone products most adaptable to particular applications—ranging from electronic components and assemblies to power distribution equipment and motors. A 12-page, fact-filled, easy to use reference. *No. 553*

Silastic Adhesive S-2200 simplifies and speeds bonding silicone rubber to metal or to itself. Easily applied, quick vulcanizing, the adhesive forms an effective bond. *No. 554*

Silicone-glass Laminates make possible design changes that result in noteworthy reductions in size and weight, yet assure reliable performance —in mechanical devices, in electrical equipment. Sizes and shapes produceable to your product requirements. *No. 555*

Outlook for 600 F Silicone Rubbers, an article from AVIATION AGE, cites the effects of aging on physical properties of Silastic stocks compounded for high temperature service. Includes information on tensile strengths, elongation, compression set. *No. 556*

First Availability. The only available specially prepared engineer's guide to selecting silicone fluids for reliable, uniform performance in viscous damping, springing, coupling and related mechanical applications. Published as a design service by Dow Corning, this file size guide has been called a "must" reference work for advance development research engineers. *No. 557*

Sources of paper and paperboard with a Syl-off silicone release coating are listed in a source of supply sheet recently published by Dow Corning. Included are producers of kraft, glassine, parchment, bags, containers and cores. *No. 558*

Dow Corning's Reference Guide gives you a complete 16-page reference to silicone products for all industries. You'll find information on defoamers, rubbers, release agents, packaging materials, lubricants, protective coatings, electrical insulation, and a variety of other engineering materials that you can use to make good products better. *No. 559*

Dow Corning Corporation, Dept. 869, Midland, Michigan

Please send me: 549 550 551 552 553 554 555 556 557 558 559

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SILICONE NEWS published for design and development engineers

first in silicones

Dow Corning CORPORATION

MIDLAND, MICHIGAN

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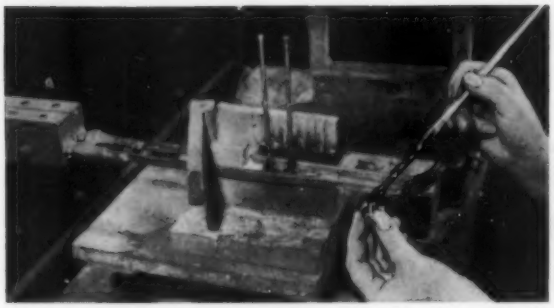
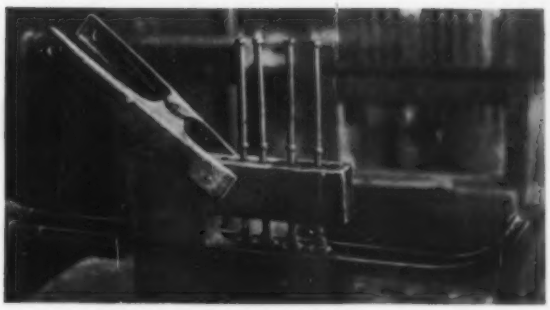


Operator applying Special Handy Flux Type B-1 to components of de-icer tube before brazing.



Here, four de-icer assemblies in jig are being brazed by induction heat.

First step in brazing manifold. Operator applies Special Handy Flux Type B-1 to joint area prior to hand brazing. B-1 Flux is particularly effective in removing refractory oxides such as those formed in stainless steels and carbides.

Operator preheats joint area before hand feeding Handy & Harman silver alloy Braze 541.

Here, two different parts are being brazed. Operator in foreground hand feeds alloy on aircraft manifold joint while operator in background brazes nipple on hydraulic oil filter. Gas-air hand torches are used in both cases.

Here's how you can get uncompromising **JOINT STRENGTH** at **LOW-COST...** Handy & Harman **SILVER BRAZING**

The first requisite for virtually any aircraft part is unimpaired strength. Jerden Manufacturing Company, Indianapolis, makes a number of tubular aircraft parts and components and each of them must pass rigid tests before acceptance. Three of the components are a hydraulic aircraft filter, a manifold assembly and a de-icing tube. Tubes and fittings are 410 and 321 stainless steel, brazed with Handy & Harman silver alloy Braze 541 (formerly 4772).

Handy & Harman's Braze 541 is specifically formulated for brazing stainless steels. It has a high flow point (1575°F), and its excellent strength at elevated operating temperatures especially recommends it for many aircraft component applications. Braze 541 is a "tailor-made" brazing alloy, designed to do a specific joining job and do it particularly well. It is an example of Handy & Harman's ability to supply a specific alloy to fit a specific need, a service that remains constantly available to you.

You may find that your metal joining requirements are more or less special or you may not be fully aware of what you require. In any case, we invite you to consult us about what you are joining and *would like to join better*. We may be able to help you from many points of view: economy, joint strength, conductivity, ease of production and many others.

GET THE FACTS

Technical Bulletins T-1 and T-2 give the general characteristics of silver brazing alloys plus the compositions, melt and flow points of 32 separate alloys. Write for your copies.

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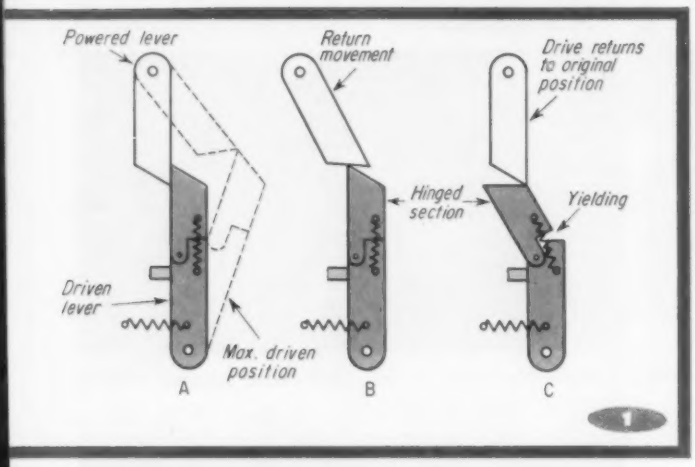
13 HANDY LEVER

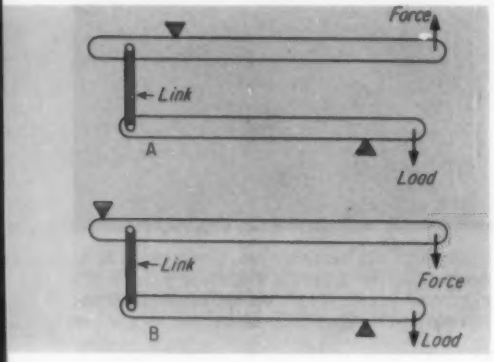
The examples of levers and linkages given here reveal versatility of these devices.

FEDERICO STRASSER, *Mankowitz & Strasser, Ltd, Santiago, Chile*



1

Composite lever . . .
mechanism acts in one direction only (A). If lever position is reversed (B) so driving lever now lies on driven lever, hinged section yields (C) to allow return of driving lever to drive position (A). Such a design can be basis of low-cost, efficient feeding mechanisms, can sometimes replace ratchet and pawl.

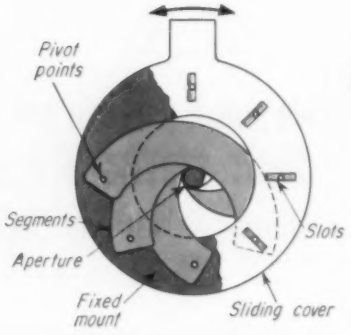


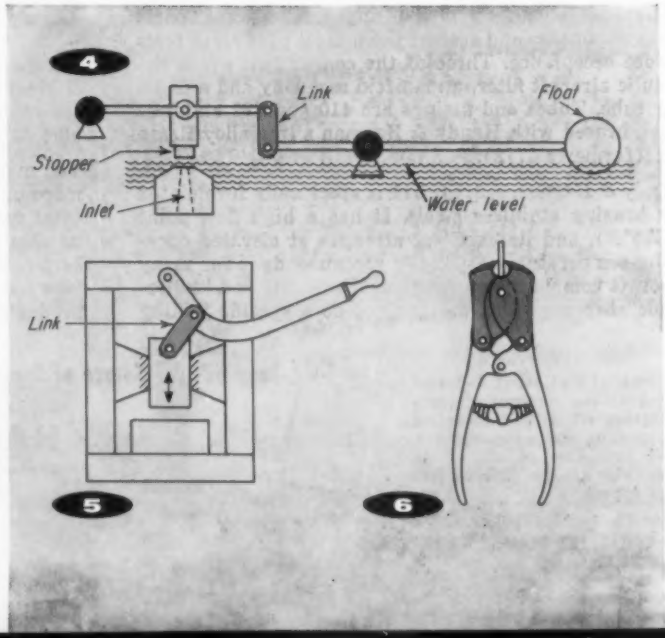
3

Compound lever . . .
arrangement results from linking chief levers. Feature of two basic linkage arrangements is that in (A) force and load act in opposite directions but input and output movement is in same direction; in (B) the opposite actions are achieved by repositioning one fulcrum.

2

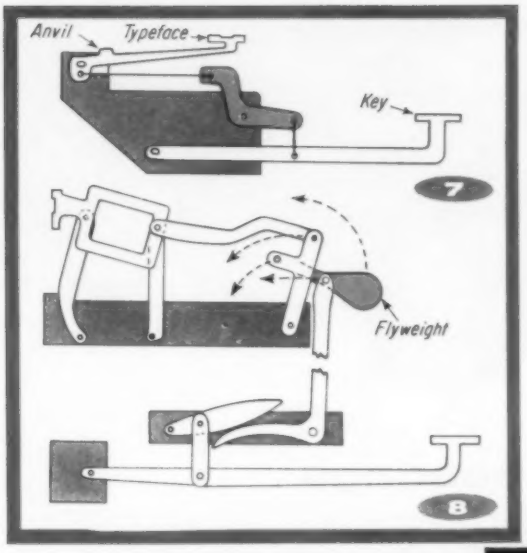
Diaphragm opening . . .
in camera is usually regulated by a series of overlapping segments. A sliding cover moves them relative to their mounting ring, thus increasing or reducing the aperture.



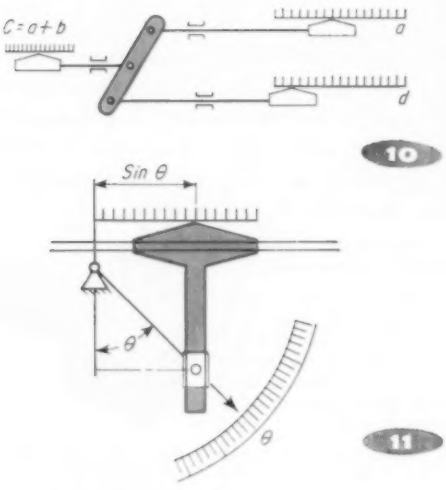


Linkages at work . . .
are represented by water-level regulator (4) such as commonly found in flush toilets. Toggle press (5) can exert, over small distances, extremely high forces compared with light force exerted by hand as, also, can multiple-lever mechanism of cutting pliers (6).

MECHANISMS

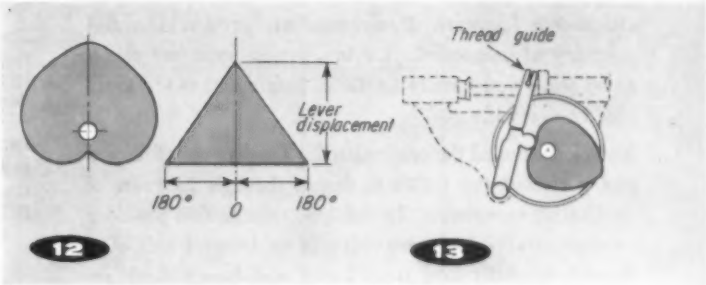


Typewriter mechanism . . .
(7) is one of many different designs where levers and linkages translate finger pressure into typescript. Arrangement here is common in portables. Note the role played by impetus in these applications. A fixed faceplate stops the anvil before the typeface actually touches the paper. But there is enough inertia in the fast-moving typeface lever to impress its character against the platen. It then recoils and stays clear of the paper even if the key is held down. "Noiseless" typewriters, more complex, have a flyweight (8) instead of the anvil-faceplate design, for "throwing" the typeface onto the paper.

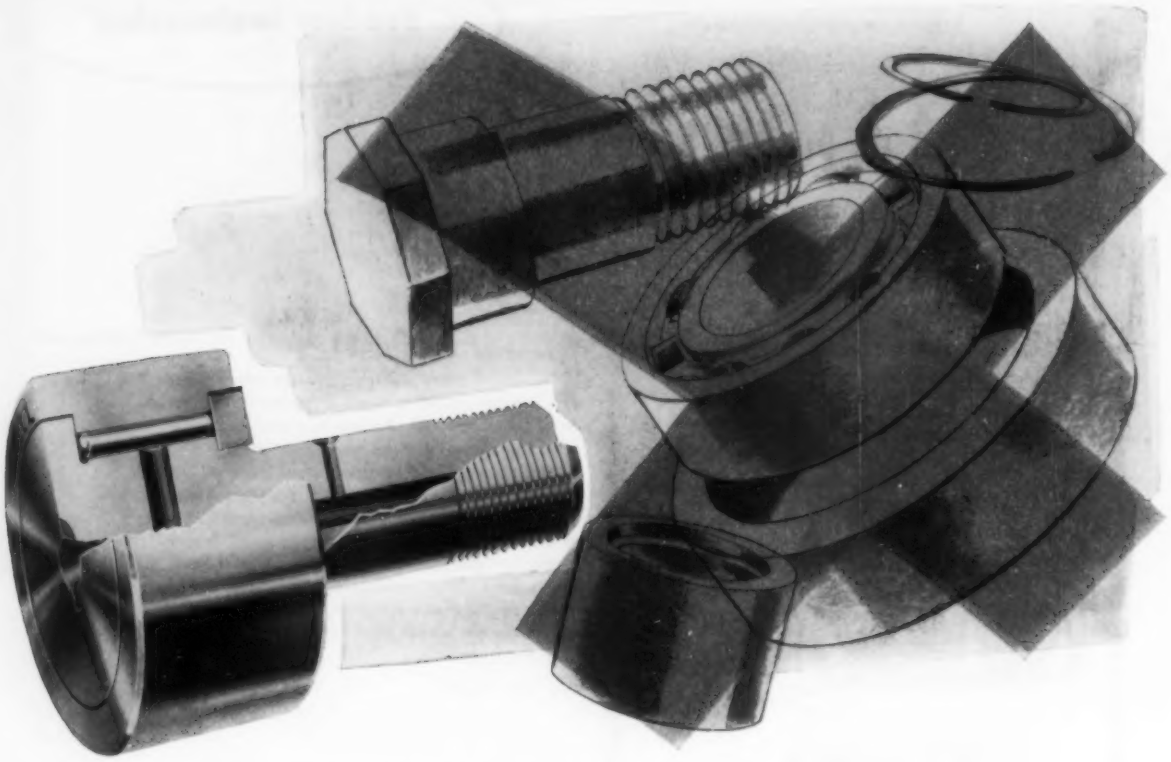


Analog computers . . .
rely heavily on levers and linkages to give mechanical analogies of mathematical operations. Here are two examples: Addition or subtraction is accomplished by the arrangement (10) shown in diagram form; arrangement (11) solves sine functions.

Pantograph principle . . .
is worth remembering for some design problems. For instance, need for extremely accurate positioning or control on assembly might be solved by pantograph ability to reproduce movements on magnified or reduced scale.



Cam and lever . . .
are often combined to produce characteristic movements. The cardioid (heart-shaped) cam (12) produces straight-line, constant-velocity motion in driven lever. This is ideal for winding machines. Sewing-machine spool winder (13) guides thread from side to side so spool spindle can turn at constant speed.



McGILL® CF *CAMROL*® bearings

eliminate the cost of producing and assembling improvised cam follower, track and guide roller units

THESE CAMROL ADVANTAGES SOLVE COST, DESIGN, PRODUCTION AND PERFORMANCE PROBLEMS:

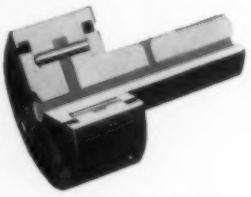
• AVAILABILITY • INTEGRAL UNIT CONSTRUCTION • HIGH LOAD CAPACITY • SMALL RADIAL SPACE REQUIREMENTS • HIGH SHOCK RESISTANCE • PRECISION ACCURACY • SIMPLIFIED LUBRICATION

You can simplify design and cut cost with CAMROL, precision cam followers. Procurement, production and assembly of components for improvised units are eliminated when you specify CAMROL bearings that are available from stock.

McGill developed the original roller bearing cam follower and perfected the CAMROL design through 25 years of application experience. Its full type construction provides exceptionally high capacity in an integral unit of a flanged, specially heat treated stud and heavy shock resistant outer race. Grease lubrication is simplified. Plain bearings require constant oil lubrication and bolt mounted ball bearings races crack under equivalent loads.

Precision construction, including concentricity of stud to outer race OD, provides accurate alignment of machine members. Ease of interchangeability and dependable operation in any cam action, track, guide or support roller application is assured. Use the CYR series in the same roller diameters for shaft mounting.

PRE-LUBRICATED SEALED CAMROL BEARINGS



These bearings combine the advantages of CF and CYR series bearings plus effective sealing against dirt, dust and grit. Ideal in applications where lubrication is a problem. Black ferrous oxide finish resists corrosion in contaminated areas.

CAMROL bearings are available in standard roller diameters from ½" to 4". Capacities to 20480 lbs. at 100 RPM.

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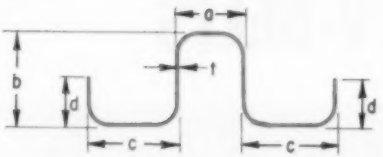
precision needle roller bearings

McGILL MANUFACTURING COMPANY, INC., BEARING DIV., 201 NORTH LAFAYETTE ST., VALPARAISO, INDIANA

this *k*-factor speeds answers for

EDGE AREA of BENT-UP SHAPES

S. WARREN KAYE, *Stress Analyst*
Flight Refueling Inc., Baltimore, Md.

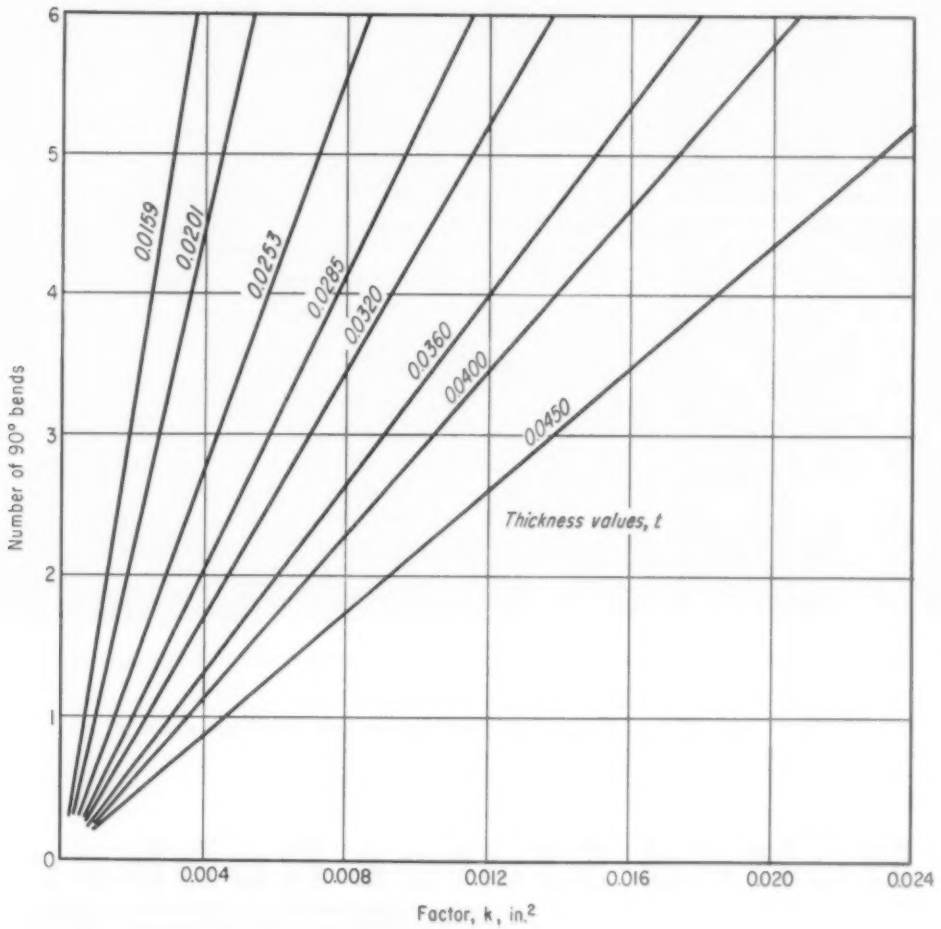


Results are between 95.5% and 99.9% accurate when edge areas, for shapes having 90° bends, are calculated from:

Area = $tS - k$

Key to simplicity of the equation is the factor k, found from curves on this or the continuing page. Value t is thickness of the material, and S is sum of sides taken as straight lines: thus in example illustrated at left,

$S = a + 2b + 2c + 2d$.



(Continued on page 103)

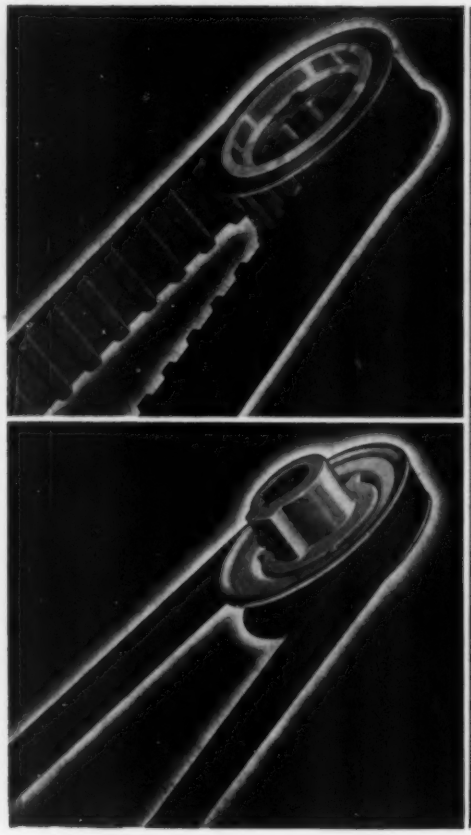
Product Engineering

R

US RUBBER **PowerGrip** "TIMING" BELTS US RUBBER UNITENSION V-BELTS

The one RIGHT type of power transmission for your appliances:

U.S. POWERGRIP "TIMING" BELTS or U.S. UNITENSION V-BELTS



CONSIDER WHAT THE U.S. POWERGRIP "TIMING"® BELT CAN DO FOR YOUR PRODUCT:

It gives a simplicity of design with split-second machine response. Built specially for appliances, this belt has teeth which fit into the grooves in the pulley, giving it an efficiency of close to 100%. There is no slippage, no take-up. You can truly stream-line your appliance design—the absence of metal-to-metal contact eliminates need for lubrication and housing devices.

You get these extra advantages: • Smaller, lower-cost motor • Short and fixed centers, high ratio • Reduces assembly costs because fewer units are needed.

The housewife gains, too! • She gains a lightweight, foolproof appliance a woman finds easy to handle, and free of the need for maintenance and service calls.

You get a product easy to demonstrate, easy to sell.

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They provide steady, dependable running on F.H.P. or multiple drives. The pulling members are electronically tensioned in perfect balance, *working as a team*—thereby increasing strength and decreasing vibration. This is the ideal belt for the mechanism that requires V-Belt power transmission.

A field force of "U. S." engineers will help you design the one *right* drive. Get to know the full meaning of the service they can give you.

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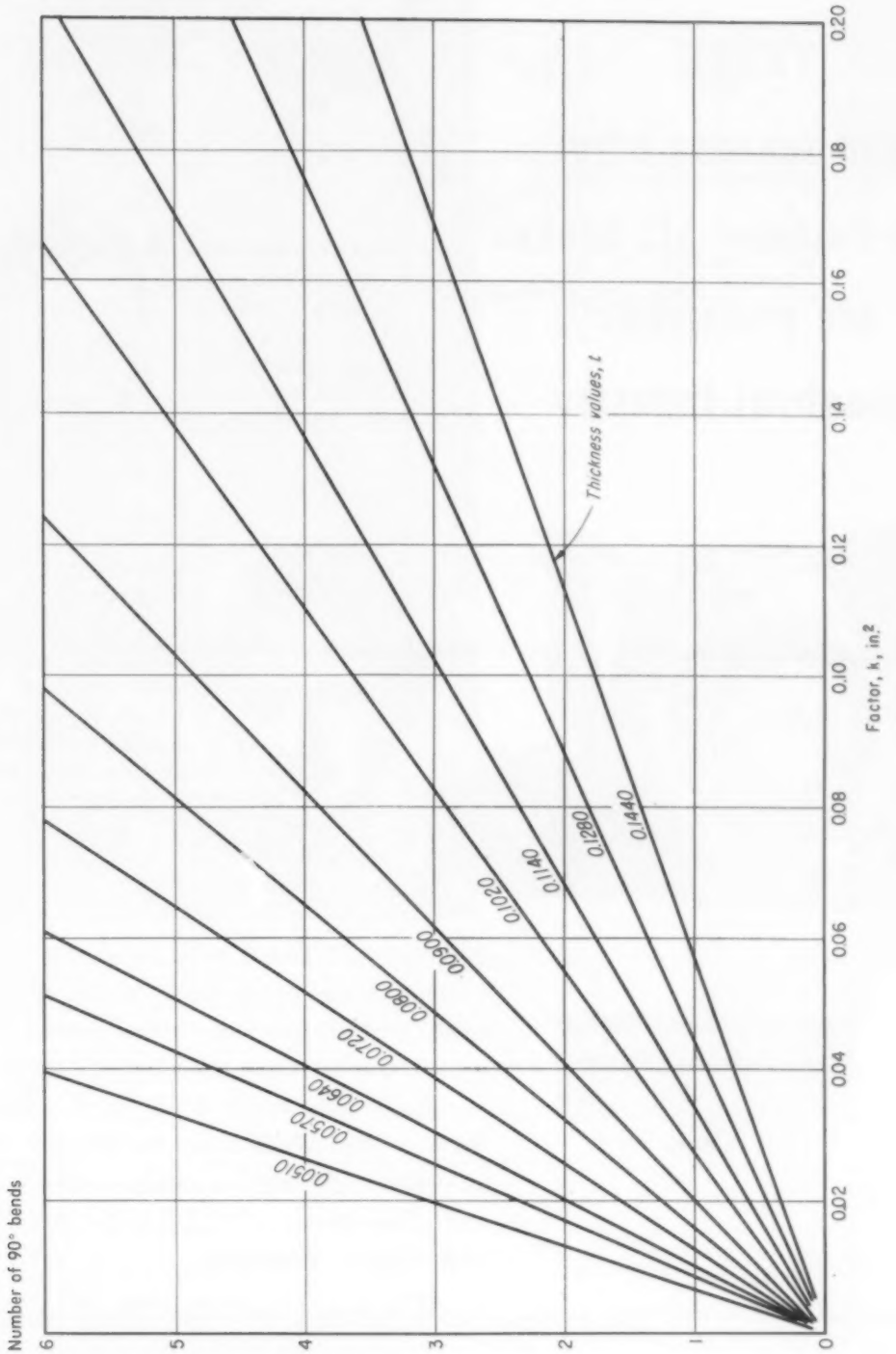
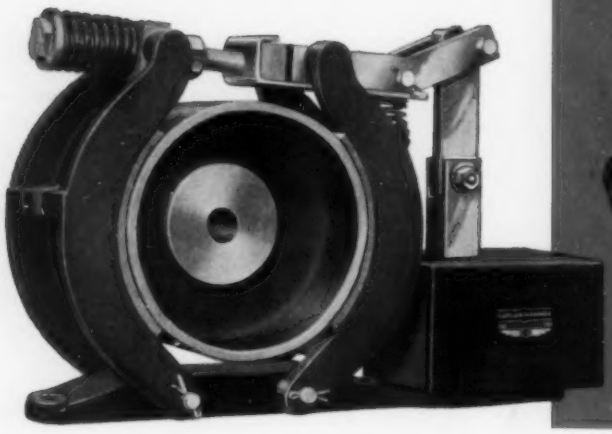
EDGE AREA of BENT-UP SHAPES (cont.)



THREE
good reasons why
Cutler-Hammer 511 brakes are preferred throughout industry



OEM DESIGN ENGINEER— "We've tested them all and standardized on Cutler-Hammer 511 Brakes. They're easier to install and our customers seem well satisfied too."

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You, too, will find it pays to specify and install Cutler-Hammer 511 Solenoid Brakes. Available for either A-c or D-c service, Cutler-Hammer 511 Solenoid Brakes are rated from 3 to 125 lbs. ft. torque continuous duty and 3 to 160 lbs. ft. torque intermittent duty. Write today for Bulletin 511-T249 for complete description, ratings, optional features, and dimensions. CUTLER-HAMMER Inc., Milwaukee 1, Wisconsin.

Cutler-Hammer Inc., Milwaukee, Wis. *Division:* Airborne Instruments Laboratory. *Foreign:* Cutler-Hammer International, C. A. *Associates:* Canadian Cutler-Hammer, Ltd.; Cutler-Hammer Mexicana, S. A.; Intercontinental Electronics Corporation, Inc.

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Ball cam-actuated valve . . .

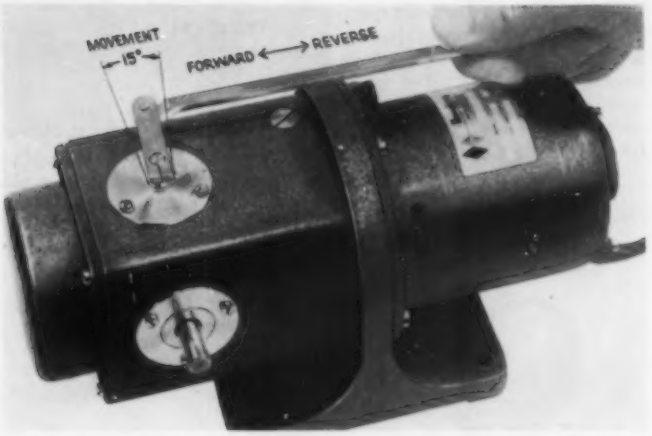
can be operated by any mechanism having linear motion. Intended for use on press controls, with air cylinders or similar applications where straight line actuation is desired, valve has a ¾-in.-dia hardened stainless steel ball spun into a stainless steel retainer. Ball rests on three stainless carrier balls in a lubricant-packed cavity. Ball cam end section can be used with any combination of 2-, 3- or 4-way valve bodies and end sections. The 3- and 4-way units are offered with open-end or piped exhaust and all valves are suitable for hydraulic and pneumatic or vacuum service. Port sizes range from ¼ through ¾ NPT. From stock, ¼-in. 3-way valve is $20.02. **Valvair Corp, 454 Morgan Ave, Akron 11.**

Circle 1, Reader Service Card

Synthetic felt seal . . .

offers weatherproofing, cold and heat resistance from —60 to 325 F, non-aging max gasketing at low gasket pressures, nominal compression set of 10% loading psi and no plastic creep. Material weighs 24 to 26 oz/sq yd, 72 in. wide and 0.165 to 0.210 in. thick. Felts are made of Dacron, Acrilan, Dynel, Arnel, Orlon, nylon or rayon fibers mechanically interlocked by a special method. All felts are said to be impervious to deleterious effects from chemicals and gases; are easy to cut, shape and work; are dimensionally stable and have high tensile strength. **American Felt Co, Glenville, Conn.**

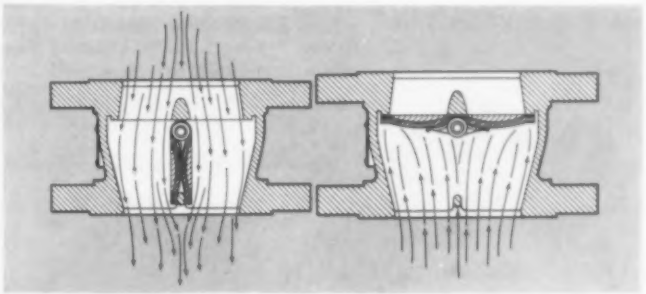
Circle 2, Reader Service Card



Push-rod speed control . . .

can be supplied with mechanical variable-speed drive for 1/70 to ¼ hp. Speed-control shaft moves through arc of 15° to shift from full speed forward to full speed reverse in less than $\frac{1}{10}$ sec without discharging load; 2 to 3 in.-oz on control shaft shifts drive. Output torque of unit is constant and efficiency is said to be between 85 and 95%. Speed is infinitely variable over full range, zero to 5000 rpm, depending on frequency. Accuracy is 0.5%. Slight control forces, such as weight of material, winding tension, hydraulic or pneumatic pressure, fed back from system, provide necessary control without amplification. Motors are rated at 115 v, 60 or 400 cps. 1/70, 1/50, 1/40, 1/20 and 1/10 hp drives are $475; 2 to 4 wk delivery. ¼ hp unit is $485; 6-wk delivery. **Humphrey, Inc, Humphrey Products Div, 3794 Rosecrans St, San Diego 10.**

Circle 3, Reader Service Card



Split-flapper check valve . . .

handles flow of all types of gases and liquids in missile ground support or industrial equipment. Through use of varied materials, it can operate in temperatures from cryogenic levels to 1000 F. Twin flappers, opening in direction of normal flow, are supported through center of piping and, in event of backward flow, their spring mounting and short, compact profile result in fast closing. Accommodates lines from 1 to 12 in. In addition to standard ASA flanges, design is also produced as an insert that can be sandwiched between piping bolt flanges. Price and delivery data not made available. **AiResearch Industrial Div, Garrett Corp, 9851 Sepulveda Blvd, Los Angeles 45.**

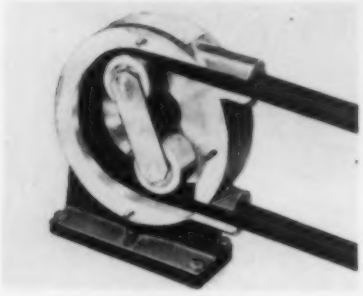
Circle 4, Reader Service Card

. . . CONTINUED ON PAGE 106

Gas turbine power package . . .

is comparable in size to a typewriter (16 in. high x 13 in. wide). Weighs 45 lb. Delivers 30 shaft hp. Can operate from sea level to 20,000 ft with shaft speed output at 6000 or 8000 rpm. Suitable as power drive for generators, alternators, liquid pumps, Freon and air compressors, blowers and other applications requiring shaft power. Applicable to boats, aircraft or ground installations. **AiResearch Mfg Co, Phoenix, Ariz.**

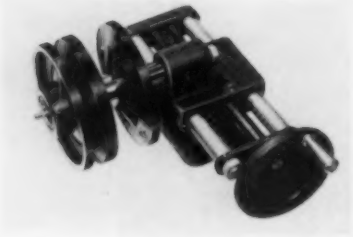
Circle 5, Reader Service Card



246-gph squeegee pump . . .

is threaded from side to ease tubing change and eliminate drip. Said to handle corrosive and sterile solutions, and abrasive slurries, virtually without maintenance. A single, continuous, flexible tube provides both inlet and outlet for pump, which completely isolates fluid from all moving parts. Solutions are squeezed through tube by a double-end ball-bearing motor. **Randolph Co, 1018 Rosine St, Houston.**

Circle 6, Reader Service Card



Variable-speed pulley . . .

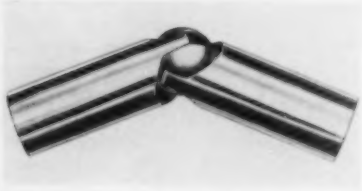
mounted on adjustable control base achieves wide range of speeds from almost any ¼ or 1-hp constant speed motor. Pulley is double variable-pitch unit that automatically adjusts driver and driven sheave belt speeds, according to distance from motor. Moving countershaft towards driver reduces driven speed; movement away from driver increases driven speed. Available in a fractional to ½-hp unit with a ratio of 6:1 with pulley dia varying from 1.875 to 4.60 and a fractional to 1-hp unit that has a 7.2:1 ratio with pulley dia from 2.40 to 6.50. Pulley assembly is needle bearing mounted on hardened and ground countershaft. **Lovejoy Flexible Coupling Co, 4906-H W Lake St, Chicago 44.**

Circle 7, Reader Service Card

Intermittent-duty motor . . .

is 115 v, 400 cps, single-phase capacitor start and run unit with a planetary gear reduction at each end. Output shaft at one end produces 1300 rpm at 144 oz-in. torque; output shaft at other end produces about 7 rpm and 160 oz-in. torque. Equipped with thermal protector. Approximately 5 x 2½ in. dia. Draws 5.5 amp under load. **Western Gear Corp, PO Box 182, Lynwood, Calif.**

Circle 8, Reader Service Card



Miniature universal joint . . .

has $\frac{7}{16}$ in. OD with a static torque rating of 250 in.-oz. Forks are nonmagnetic stainless steel and ball is bronze. Three-part construction is said to have min backlash. Max angle of operation is 20°. Over-all length is 1 in. Available with standard bore $\frac{3}{16}$ x $\frac{7}{16}$ in. deep and also solid and oversize to meet special applications. **Curtis Universal Joint Co, Inc, 4 Birnie Ave, Springfield 7, Mass.**

Circle 9, Reader Service Card

Hydraulic motors . . .

are rated for 3000-psi starting pressure, 25-psi stalled torque. Over-all efficiency is said to be 90%. The 0.6 cu in./rev motor (3.5 gpm at 1500 rpm when used as a pump) is offered in three variations. A standard model is intended for continuous duty at speeds to 4500 rpm and at oil temperatures to 275 F; a second is for continuous duty at speeds to 6400 rpm and at oil temperatures to 275 F; a third is for applications involving oil temperatures to 400 F. Motor weighs 5.7 lb. **Watertown Div, New York Air Brake Co, Watertown, NY**

Circle 10, Reader Service Card

Multiple-function counters . . .

are applicable to all types of machinery, manufacturing, packaging and auditing operations, and to any measurement translatable into digital units. Photoelectric, magnetic and proximity-type actuating devices are included. Each device in series is for a specific application and for specific operating conditions. Plug-in electronic circuits permit replacement of defective units. Also, in many cases, same plug-in units can be used by a whole series of counters and control devices, though each performs entirely separate and varied operations. Extra pulse circuits, for machine or quality control or for monitoring, may be added. From 1 to 20 devices can be tied in with a data printout logger for decentralized operations responsible to a central auditing system. **Sterns Control Corp, 220 E Shore Rd, Great Neck, NY**

Circle 11, Reader Service Card

Continuous strip switch . . .

makes electrical contact at pressure of about 8 oz. Has black vinyl jacket profile with bead added to top of extrusion. Connectors and end seals are available. Bends without shorting and remains sensitive for switching. May be cemented to soft rubber backing. Rated for 1 amp at 115 v ac, resistive, but operation below 30 v is recommended to meet most regulations. Price is about 81¢ per ft in small quantities. **Tapeswitch Co of America, 116-46 228th St, Cambria Heights 11, NY.**

Circle 12, Reader Service Card

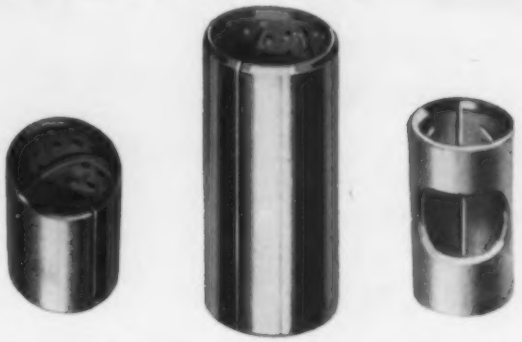
Heavy-duty separator . . .

is said to be capable of automatically filtering, separating and discharging up to 500 gph of moisture and sludge with no loss of air. After each discharge, unit resets for next operating cycle. Unit has two stages: separation and discharge of moisture and heavier contaminants is float-operated and may be used on continuous or intermittent air flow; then textile cartridge filters air and removes solid particles

. . . CONTINUED ON PAGE 108

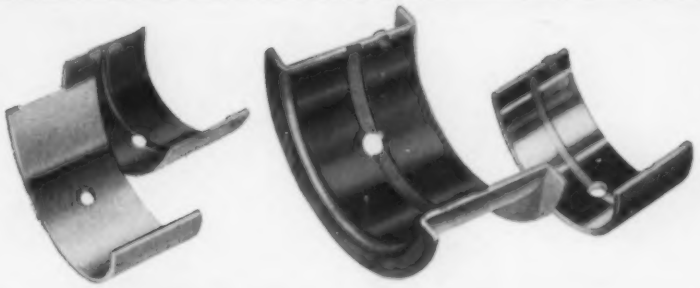
Bimetal and Plain Bushings offer substantial economies

Rolled split plain bronze, steel or aluminum; or steel lined with bronze, babbitt, medium or heavy-duty copper-alloy, or extra heavy-duty aluminum alloy. Many design variations possible, plus volume production economies.



These alloy linings meet 95% of engine bearing needs

Experience shows a steel back, lined with tin- or lead-base babbitt, medium- or heavy-duty copper-alloy or extra heavy-duty aluminum alloy, meets most performance requirements.

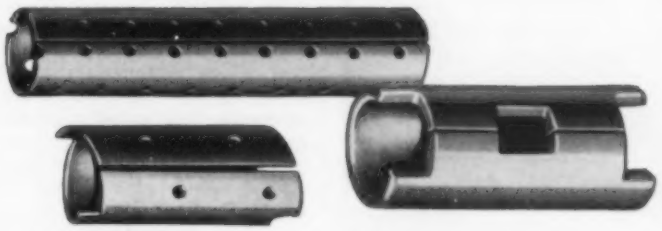


Precision Thrust Washers in Bronze or Bronze on Steel

Cold rolled for heavy duty. Steel faced with copper-alloy on one or both faces. Nibs, lugs, coined oil grooves. Flat, spherical or special shapes. From 1″ to 6″ O.D.

Economical Spacer Tubes for Hundreds of Applications

Money-saving substitute for iron pipe, tubing or machined parts. Delivered ready for assembly, to exact dimensions —or can be brazed to other components.



FEDERAL Mogul SINCE 1899

FEDERAL-MOGUL DIVISION

FEDERAL-MOGUL-BOWER BEARINGS, INC., 11043 SHOEMAKER, DETROIT 13, MICHIGAN

RESEARCH • DESIGN • METALLURGY • PRECISION MANUFACTURING

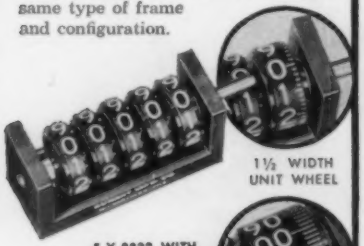
96 STANDARD VARIATIONS

New Y

DIGITAL READ-OUT COUNTERS

by **DURANT**

Design engineers can now select one or more standard units from a range of 96 Instrument Counters, having the same type of frame and configuration.



1½ WIDTH UNIT WHEEL

5-Y-8822 WITH SINGLE WIDTH UNIT WHEEL

SINGLE BANK SERIES
(Right or Left Drive)
2 to 7 Figures

DOUBLE WIDTH UNIT WHEEL

Here is a family group that provides uniformity in digital recording to satisfy nearly all design requirements . . . on radar equipment, navigation instruments, computers, missile tracking devices, and gauging instruments.

They are compact, average weight only 2 ounces, have easy to read figures, white on black . . . speeds to 2500 RPM. Available in single or dual bank style, in 2 to 7 figures capacity . . . three styles of unit wheel configuration.

4-4-Y-8831 WITH 1½ WIDTH UNIT WHEEL

DUAL BANK SERIES
(Right or Left Drive)
2 to 5 Figures EA. BANK

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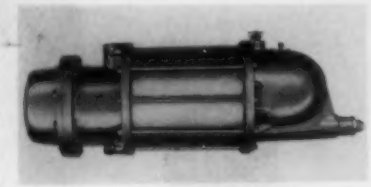
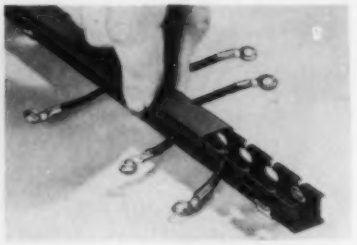
DURANT MFG. CO.
4938 N. Buffum St., Milwaukee 1, Wis.
38 Thurbers Ave., Providence 5, R.I.
Representatives in Principal Cities

PRODUCTIMETERS SINCE 1879 *Count Everything*



as small as 5 microns, oil and oil sludge. Max operating pressure is 250 psi. Available in pipe sizes from ¼ to 3 in. NPT. **Wilkerson Corp, 1656 W Girard Ave, Englewood, Colo.**

Circle 13, Reader Service Card



Miniature wiring duct . . .

in a range of sizes with snap-in slot design allows wire to be laid after terminals have been attached. Duct slots are separated by individual plastic fingers that flex to permit wire to be inserted, then snap back. Vinyl plastic raceway may be mounted with a snap-type spring steel clip supplied by manufacturer or an ordinary screw may be used through hole drilled by user. **Panduit Corp, Dept PGT, 14461 Waverly Ave, Midlothian, Ill.**

Circle 14, Reader Service Card

Hydraulic pumps . . .

have capacities from 18 to 124 gpm at 1200, 1800 and 2400 rpm and 1000 psi in five sizes. Built to absorb and perform well under heavy shock loads, the gear-type pumps are especially suitable for heavy earth-moving and construction equipment. Gear widths are 1, 1½, 2, 2½ and 3 in. Pump is said to eliminate excessive plumbing and permit installation close to source of operation. **Webster Electric Co, Racine, Wis.**

Circle 15, Reader Service Card

Two-bolt sleeve bearing . . .

is said to be interchangeable with most 2- and 4-bolt units. Designed for side or flange mounting. Available with graphite-filled bronze bushing or with a sintered bronze bushing, both of which are self-lubricating. Available for six standard shaft sizes from ¼ through 1 in. for general use where severe stress conditions do not prevail. Bolt size is standardized at ⅜ in.

(Continued on page 110)

MEEHANITE CASTINGS ARE MADE ONLY BY MEEHANITE FOUNDRIES

The American Laundry Machinery Co., Rochester, N. Y.
Atlas Foundry Co., Detroit, Mich.
Banner Iron Works, St. Louis, Mo.
Barnett Foundry & Machine Co., Irvington, N. J.
Blackmer Pump Co., Grand Rapids, Mich.
E. W. Bliss Co., Canton and Toledo, Ohio
Centrifugally Cast Products Div., The Shenango Furnace Co., Dover, Ohio
Compton Foundry, Compton, Calif.
Continental Gin Co., Birmingham, Ala.
The Cooper-Bessemer Corp., Mt. Vernon, Ohio and Grove City, Pa.
Crawford & Doherty Foundry Co., Portland, Ore.
Empire Pattern & Foundry Co., Tulsa, Okla. and Bonham, Texas
Florence Pipe Foundry & Machine Co., Florence, N. J.
Fulton Foundry & Machines Co., Inc., Cleveland, Ohio
General Foundry & Mfg. Co., Flint, Mich.
Georgia Iron Works, Augusta, Ga.
Greenlee Foundries, Inc., Chicago, Ill.
The Hamilton Foundry & Machine Co., Hamilton, Ohio
Hardinge Company, Inc., New York, N. Y.
Hardinge Manufacturing Co., York, Pa.
Johnstone Foundries, Inc., Grove City, Pa.
Kanawha Manufacturing Co., Charleston, W. Va.
Koehring Co., Milwaukee, Wis.
Lincoln Foundry Corp., Los Angeles, Calif.
Nordberg Manufacturing Co., Milwaukee, Wis. and St. Louis, Mo.
Palmyra Foundry Co., Inc., Palmyra, N. J.
The Henry Perkins Co., Bridgewater, Mass.
Pohlman Foundry Co., Inc., Buffalo, N. Y.
The Prescott Co., Menominee, Mich.
Rosedale Foundry & Machine Co., Pittsburgh, Pa.
Ross-Meehan Foundries, Chattanooga, Tenn.
Sonith Industries, Inc., Indianapolis, Ind.
Standard Foundry Co., Worcester, Mass.
The Stearns-Roger Mfg. Co., Denver, Colo.
Valley Iron Works, Inc., St. Paul, Minn.
Vulcan Foundry Co., Oakland, Calif.
Washington Iron Works, Seattle, Wash.
Dorr-Oliver-Long, Ltd., Orillia, Ontario
Hartley Foundry Div., London Concrete Machinery Co., Ltd., Brantford, Ontario
Otis Elevator Co., Ltd., Hamilton, Ontario

WRITE TODAY FOR YOUR FREE SINGLE COPY OF THIS INFORMATIVE BULLETIN.

BEHAVIOR OF CASTINGS AT ELEVATED TEMPERATURES — *BULLETIN TD-7*

Write today to Meehanite Metal Corporation, Department 7G, 714 North Avenue, New Rochelle, N. Y.

MEEHANITE ®

HEAT RESISTANCE

These Meehanite®, type HS, annealing baskets support over 2000 lbs. of bar stock castings during heat treat cycles at 1450°F for five hours without growth, scaling or premature cracking. They are made by Centrifugally Cast Products Div., the Shenango Furnace Co., Dover, Ohio.

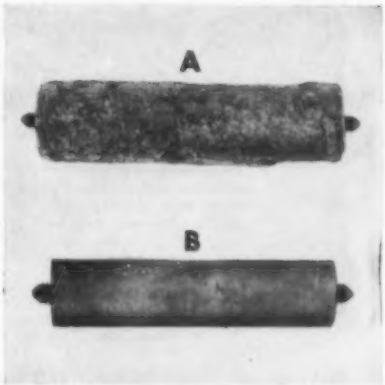
Heat resisting Meehanite castings provide dependable service at high temperatures

Metal parts subjected to high temperatures undergo dimensional and structural changes which can lead to premature cracking or surface disintegration and scaling. These serious causes of failure can be avoided by selecting materials capable of withstanding the specific heat stresses involved.

The stabilized structure of Meehanite metal is particularly suitable for engineering applications where components must function dependably under steady or cyclic high temperature conditions.

This dependability of Meehanite® at elevated temperatures has led to its acceptance as a standard material for annealing pots, dies and fixtures, ingot molds, stoker parts, steel mill furnaces, smelting, cement and roasting furnaces, tube mill furnace rolls, incinerator liners, etc.

There are ten types of heat-resisting Meehanite metals available from which selection can be made according to conditions of service at high temperatures. For more detailed information write for a copy of our new, 4 page bulletin TD-7 — "Behavior of Castings At Elevated Temperatures" — or call the Meehanite foundry nearest you.



Test casting A, made from alloy gray iron was heat-treated for 300 hours at 1700°F in an oxidizing atmosphere. Severe growth and scaling is evident. Casting B, made from SC Meehanite® was given the same heat test. No growth or scaling occurred.

MEEHANITE BRIDGES THE GAP BETWEEN CAST IRON AND STEEL®

MEEHANITE METAL

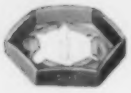
MEEHANITE METAL CORPORATION, NEW ROCHELLE NEW YORK

PALNUT® LOCK NUTS and FASTENERS

REDUCE —PARTS —OPERATIONS —ASSEMBLY COSTS

PALNUT Lock Nuts are precision-made of tempered spring steel—cost less than plain nuts—save 65-85% in fastener weight—save space—eliminate lockwashers and flat washers—assemble easily and fast with standard tools, extra-fast with PALNUT Magnetized wrenches—hold tight under vibration. Other specialized PALNUT Fasteners provide big savings and better assemblies on unthreaded studs, rods, rivets, pins and shafts.

PALNUT LOCK NUTS for Threaded Assemblies



Regular Type. Used alone as a load-carrying nut on light duty assemblies or used on top of ordinary nuts on high stress assemblies.

Washer Type. Lock nut and washer in one piece, replaces ordinary nut, lock washer and flat washer. Many design variations.

Inverted Type. A compact lock nut for light duty assemblies. Pleasing round dome.

Wing Type. Combines locking principle of PALNUTS with ease of finger tightening and removal.

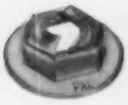
Acorn Type C. Smooth dome shape covers up unsightly, rough bolt ends for attractiveness and protection against scratching.

Acorn Type CK. Semi-acorn type, used as a lock nut when seated—or as an adjusting nut or stop nut anywhere on threads.

Tension Nuts. Hold adjusting screws to desired setting. Easy assembly—simple adjustment.

Self-Retaining Nut. Spring-tempered steel captive lock nut for #8-32 screws in blind applications. Flared sides retain nut in slots or cavities.

FASTENERS for Unthreaded Studs, Rods, Pins, etc.



Washer Base

Regular Hex

SELF-THREADING NUTS

Form their own deep, clean threads while tightening on unthreaded zinc die-cast studs; also on unthreaded rod or wire of steel, aluminum or brass. Save threading costs. Fast assembly with standard tools. Provide vibration-proof grip, whether seated for load-carrying or unseated as a "stop nut". Remove and re-use on same studs. Sizes for 1/4", 3/16" and 1/4" dia.

Cap Type W

Flat Type H

PUSHNUT® FASTENERS

Simply push or tap on unthreaded studs, rod, wire or rivets. Save threading, notching, drilling for cotter pins. Strong spring grip resists removal. Low in cost, fast assembly. Many types and sizes

Acorn Type C closed end

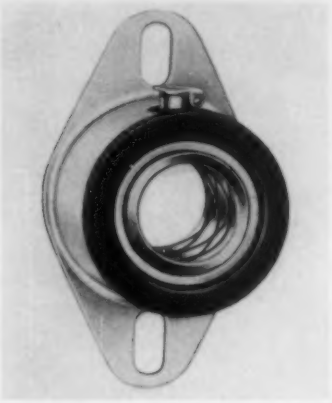
Acorn Type CK open end

Write for Catalog 573-C and Free Samples, stating type, size and application.

THE PALNUT COMPANY, 65 Glen Road, Mountainside, N. J.
In Canada: P. L. Robertson Co., Ltd., Milton, Ont.

PALNUT® LOCK NUTS FASTENERS PAL

Quick, secure fastening at low cost



One-piece housing is 16-gage steel with cadmium finish. A rubber liner isolates bearing. **Randall Graphite Bearing, Inc, Lima, Ohio.**

Circle 16, Reader Service Card

High-pressure switch . . .

for hydraulic systems has range adjustable from 550 to 5000 psi. Designed for heavy-duty industrial applications, switch incorporates a strain relief mechanism to prevent damage from shock of violent pressure surges. Oil-tight construction prevents leakage into enclosure. Operating rates to 300 per min are said to be possible. **Square D Co, 4041 N Richards St, Milwaukee 12.**

Circle 17, Reader Service Card

Explosionproof control . . .

for air, gas or liquid pressures in hazardous locations where explosive gases or vapors are present. Two separate switches permit independent switch actions, control of two independent circuits. Unit is uncalibrated. Pressure settings are made by removing cover and setting hex-head adjustment screws. Switches may be set together to simulate double-pole circuitry or set apart to obtain independent operation. Cast-iron base and aluminum cover construction permits its use in Class I, groups C

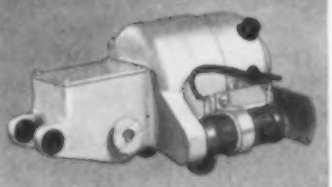
(Continued on page 114)

PASSES TESTS WITH FLYING COLORS

Aircraft de-icing pump motor.

Impact concrete drill motor.

Explosion-proof vacuum unit.



Gear motor for slow-speed drive.

If you are interested in any of the above motors write and we shall be glad to send full information.

...equal dependability for your product

One of the recent Lamb Electric developments is a motor to drive submerged pumps on military aircraft—for transfer of fuel from reserve to engine tanks.

For such an important application, motor reliability far beyond that normally called for was needed. To insure this degree of reliability in its actual operation of driving the submerged pump, test requirements for the motor were exceptionally rigorous.

As the result of advanced engineering and design, greatly increased brush life, and ability to operate at extremely high temperatures and withstand severe shock tests, the motor passed gruelling tests with flying colors.

The skill and experience exemplified here is available to your company to provide dependable power for *your* new or redesigned products.

THE LAMB ELECTRIC COMPANY • KENT, OHIO

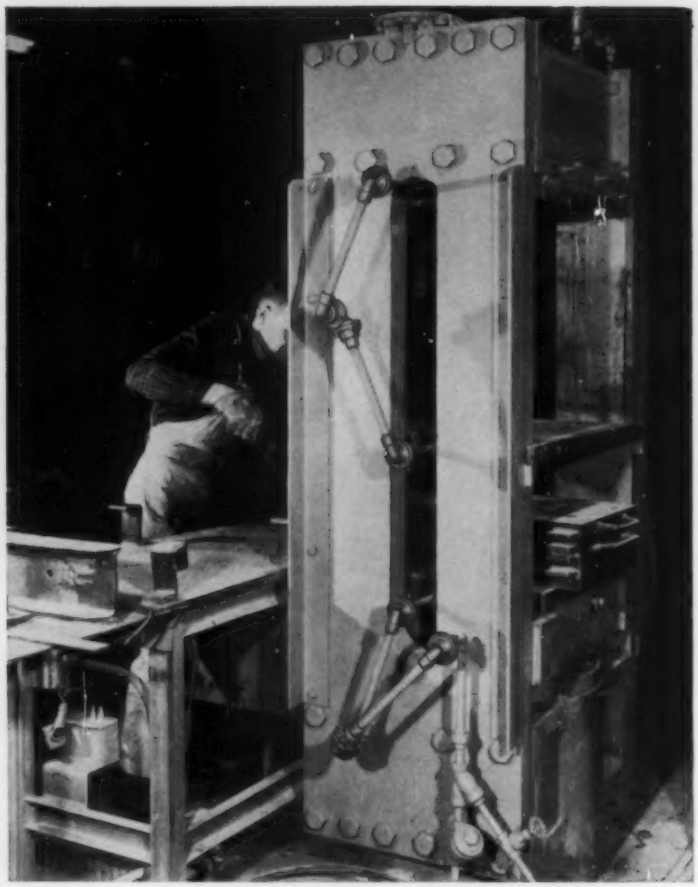
A Division of American Machine and Metals, Inc.

In Canada: Lamb Electric—Division of Sangamo Company Ltd.—Leaside, Ontario

Lamb Electric

SPECIAL APPLICATION FRACTIONAL HORSEPOWER **MOTORS**

STEEL LINES FOLD LIKE AN ACCORDION Typical of diverse swivel joint applications, newly designed Chiksan Discpak joints are installed on the steam lines of a platen press. This new type swivel joint, designed for hot gas and steam, allows inexpensive packing replacement without removing swivel joint from line.



WHEN *design*
DICTATES
METAL LINES . . .

SOLVE LINE FLEXING PROBLEMS

with **CHIKSAN SWIVEL**

Chiksan swivel joints allow metal lines to be flexed in predetermined travel arcs, eliminate hose rupture, reduce maintenance and replacement costs.

Where tight bends in pressure hose make wide loops necessary, Chiksan swivel joints, conversely, permit compact placement of lines. When used with hose, Chiksan swivel joints shorten hose lengths and also lengthen hose life by minimizing tight bend and torsional fatigue.

Chiksan swivel joints are available from stock in a wide range of materials, temperatures, and pressures to meet practically every design requirement. Chiksan swivel joint packing units are designed for specific services. For example, packings have been developed to efficiently handle non-inflammable hydraulic fluids. Write today for catalog and name of nearby sales engineer.

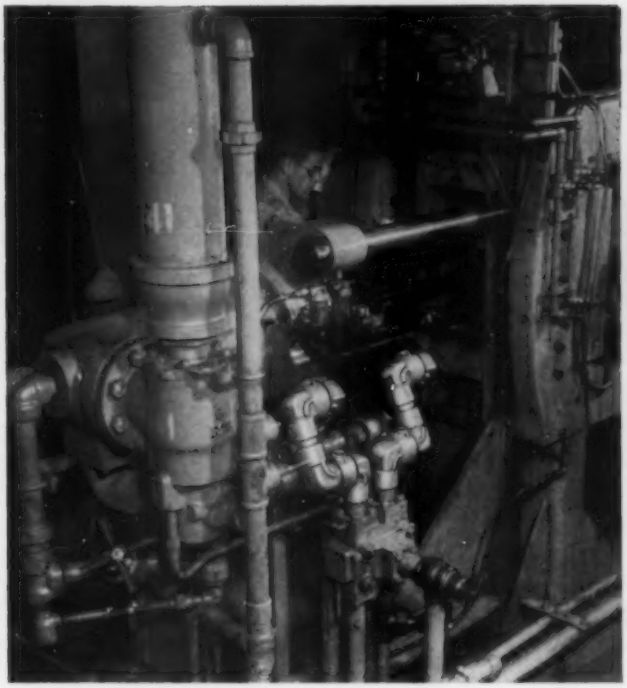
LONG SERVICE LIFE ➤ Chiksan swivel joints deliver years of service with only occasional maintenance attention. All-steel hydraulic lines on Flash-Butt welder, shown at right, allow lines to shift as machine is adjusted to handle various work.

A SUBSIDIARY OF FOOD MACHINERY AND CHEMICAL CORPORATION

fmc **CHIKSAN**

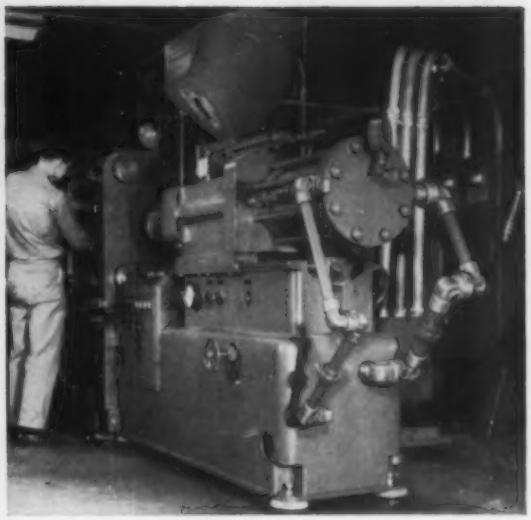
CHIKSAN COMPANY–BREA, CALIFORNIA • CHICAGO 5, ILLINOIS • NEWARK 2, NEW JERSEY

Well Equipment Mfg. Corp. (Division), Houston 1, Texas • Subsidiaries Chiksan Export Company • Chiksan of Canada Ltd



NO HOSE BURST DANGER HERE...

Critical lines take on a new measure of safety with all-steel flexible units replacing pressure hose. These all-metal swivel jointed lines shown on a die casting machine above, eliminate damaging hose ruptures, and reduce fire hazard, fluid loss and setup time by 75%.



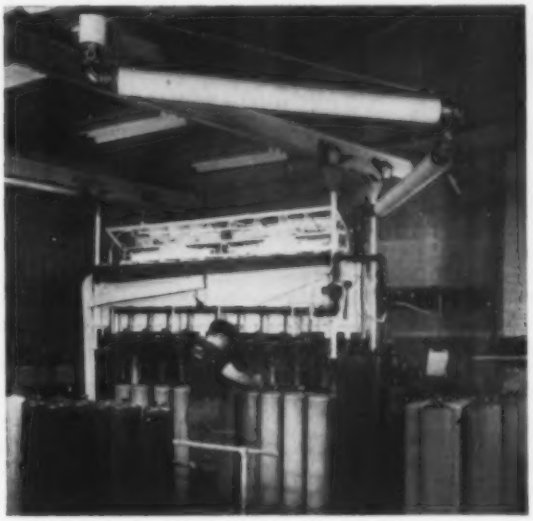
PRESSURE? TEMPERATURE? CHIKSAN MEETS THE NEED...

Over 2,000 different types, styles and sizes in a variety of temperature and pressure ratings are available to meet your design needs. This plastic injection molding machine, above, uses two different sizes of Chiksan swivel joints on its hydraulic lines.

JOINTS

NO LIMIT ON LINE DESIGN

Free swiveling action in 1, 2 and 3 planes permits design of compact lines to meet any requirement. This overhead line in service at a water softener regenerating plant permits shift from one setup of tanks to another for faster handling of tank regeneration.



#58-31

CHIKSAN COMPANY
330 NORTH POMONA AVENUE, BREA, CALIFORNIA

Please send me copy of your latest catalog

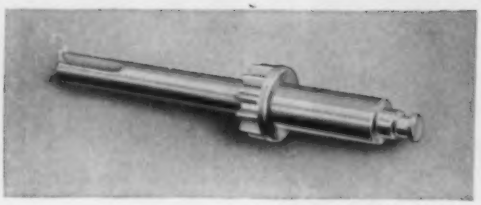
Name_____ Company_____

Title_____ Address_____

City_____ Zone_____ State_____

here's PROOF of how the GRC method cuts the cost of small parts...

Take, for example, this part which previously had been produced 3 different ways...



METHOD A

ASSEMBLY OF 2 SCREW MACHINE PARTS

Screw Machine Part

Mill Slot

Machined Extrusion

Assembly

4 Production Steps

+ 3 inspections

METHOD B

CONVENTIONAL DIE CAST AND MACHINED PART

As Cast

Trimmed

Machining for Undercut and Sizing of Diameters

3 Production Steps

+ 2 inspections

the GRC method

AUTOMATICALLY DIE CAST

1 Production Step

—only one inspection

Now take a look at these comparative figures . . .

	Purchased Material	Cost/M	Scrap Generation	Cost in lots of 100 M	500 M
Method A	Brass	$30	30%	$70/M	$69/M
Method B	Zinc Alloy	$3.82	5%	$30/M	$28/M
GRC Method	Zinc Alloy	$3.64	None	$15/M	$11.50/M

Check the chart; you'll see clear proof of how GRC's DIE CASTING METHOD offers substantial savings on your small parts. The Gries Method delivers parts of high uniformity, with close tolerances . . . ready for use. Assembly and most other secondary operations are eliminated.

Write, wire, phone NOW for GRC's bulletin "Small Die Casting Exclusively", send prints for quotation.

MAXIMUM SIZES: 1¾" long, ½ oz. NO MINIMUM

GRIES

GRIES REPRODUCER CORP.

World's Foremost Producer of Small Die Castings

159 Beechwood Ave., New Rochelle, New York • NEw Rochelle 3-8600

and D; Class II, groups E, F and G; Class III, as defined by NEMA. Rated for 15 and 20 amp at 115 to 230 v ac. All switches are single pole and suitable for ambient temperatures to 180 F. Approximate weight, 5 lb. **United Electric Controls Co, 79 School St, Watertown, Mass.**

Circle 18, Reader Service Card

Electronic delay relay . . .

is factory preset for delay times from 50 millisec to 50 sec. Unit has transistor control circuit, with a relay contact as only moving part, and offers instantaneous recycling. Contact rating is 5 amp, resistive. Hermetically sealed relay is said to withstand shock and vibration. Operates accurately on 18 to 32 v dc and in temperatures from —67 to 159.8 F. Relay can be delayed pull-in or delayed drop-out. **Master Specialties Co, 956 E 108th St, Los Angeles 59.**

Circle 19, Reader Service Card

Dc motor brakes...

include 10, 13, 16, 19 and 23-in. wheel sizes. Hinged at top for equal distribution of applied pressure. Mounting holds shoes in spring-loaded sockets without pins to connect them to arms. Brake shoes are self-aligning and interchangeable end-for-end and with each other. All adjustments can be made from top of brake. A single adjustment, with built-in indicator, sets airgap. Removal and replacement of brake wheel and motor armature, as a unit, can be accomplished without disturbing torque adjustment. Main torque adjustment spring is at bottom of brake, totally shielded. Brake coil is encapsulated in baked epoxy plastic. Cast steel brake, with cast aluminum shoes, has pressure lubricated bushings and hardened pins. Parts are said to be designed for rigidity. **Clark Controller Co, 1146 E 152nd St, Cleveland 14.**

Circle 20, Reader Service Card

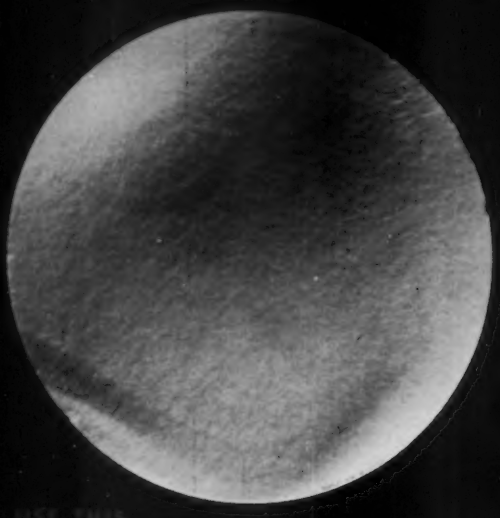
Three-way servo valve...

employs concentric spools to provide a two-stage closed servo-loop with unity positional gain. Input breakout friction is said

(Continued on page 118)

USE *Coors* CERAMICS

WHERE YOU WANT RELIABILITY



USE THIS

This is an unretouched photo of a broken 3" thick section of Coors high alumina ceramic, formed by the *Isostatic Process*. It fractured smoothly and shows a completely homogeneous structure. There are obviously no voids or hidden stresses to cause failure.

NOT THIS

This is an unretouched photo of a broken 3" thick section of high alumina ceramic, formed by the conventional wet process. It clearly shows typical voids and hidden stress patterns inherent in all conventionally made, wet process ceramic parts.

COORS TECHNIQUE PRODUCES UNIFORM PARTS WITH NO HIDDEN VOIDS OR INTERNAL STRESSES

Design uncertainties of ceramic strength and unformity are completely eliminated by the use of Coors Alumina Ceramics formed by the *Isostatic Process**. There are no variations in properties between one ceramic part and another. This is the only ceramic forming technique that can guarantee uniformity between ceramic parts.

Outside of the spark plug field, Coors has pioneered in isostatically forming high alumina ceramics. In this forming technique, blanks are initially produced by pressing dry, unfired powder in a rubber mold under high hydraulic pressure. An accurate inside contour can be formed by pressing the powder around a metal arbor. The uniform pressure from all directions provides uniform compactness and complete homogeneity. The final outside shape is formed by machining the blanks.

In a wet process, the ceramic parts, once formed, must be dried. This drying action causes hidden stresses to develop. And finally, the volume occupied by the water is replaced by air, forming hidden voids and weak spots.

Since the powdered ceramic material used in the *Isostatic Process* is dry before it is formed, the machined blanks go directly into the high temperature kilns. Unpredictable drying necessary in wet processes is thus eliminated.

With Coors Alumina Ceramic parts made by the *Isostatic Process*, the engineer can accurately design for mechanical and electrical properties—an impossibility with any ordinary methods of forming ceramic. For complete mechanical and electrical properties, send the coupon below. Parts to test your design will be furnished at nominal cost.

**Coors Porcelain Company operates under license for this patented process from Champion Spark Plug Company, Toledo, Ohio.*

COORS PORCELAIN COMPANY

Manufacturers of High Strength Alumina Ceramics

GOLDEN, COLORADO

COORS PORCELAIN CO., 686 9th St., Golden, Colo.

Please send me detailed Bulletin 1055-A on Coors High Strengt
Alumina Ceramics and Coors manufacturing facilities.

Name.....Title.....

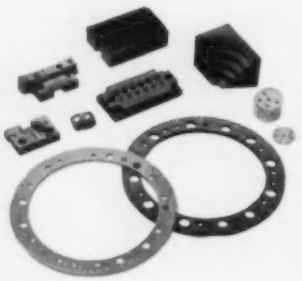
Company.....

Address.....

City.....State.....

Please refer to our 12-page catalog in Sweet's Product Design Fi

A plane's best friend is Reliability



Aircraft parts of Synthane laminated plastics combine light weight, strength and electrical insulating properties.

Almost anyone who flies spells "Reliability" with a capital "R". Which is one reason why the aviation industry is a good customer for Synthane laminated plastics. There are other reasons.

Synthane is a material with many useful properties in combination. It's light in weight (half the weight of aluminum). It's an insulator with high dielectric strength, low dielectric losses, excellent insulation resistance. It's easily machined and resistant to chemicals. You'll go far to find one material with all these desirable characteristics.

But Synthane is more than a material. It is an investment in reliability. Quality control from the raw materials to the finished product assures you of uniformity and rigid compliance with your most exacting requirements.

Synthane is people. People who have grown up with our company and take pride in turning out a first-class job. People to whom promises of delivery mean something. People who are specialists in working with laminated plastics. In short, people you can count on. What does all this cost you? Little or no more than you are now paying for other plastic laminates.

If you are interested in a reliable source of laminated plastics, you might remember that after "R" for Reliability comes "S" for Synthane . . . and Service.

SYNTHANE

SYNTHANE CORPORATION, 4 RIVER ROAD, OAKS, PA.

chances are you'll find Caplugs ideal for your closure needs, too . . . they're made of tough, flexible Polyethylene . . . easy to apply and a cinch to remove . . . won't chip, break, shred or collapse . . . over 500 sizes in a dozen different styles now on the shelf.

Caplugs

QUICK, SLICK PROTECTION FOR PRODUCTS IN PROCESS, STORAGE AND TRANSIT

GET THIS KIT FULL OF SAMPLES IN EXCHANGE FOR THE COUPON ATTACHED

CAPLUGS DIVISION, PROTECTIVE CLOSURES CO., INC.
2205-9 Elmwood Ave., Buffalo 23, N.Y.

Mail a free assortment of Caplugs, literature and prices to us, without obligation.

NAME _____ TITLE _____

FIRM _____

ADDRESS _____

CITY _____ ZONE _____ STATE _____

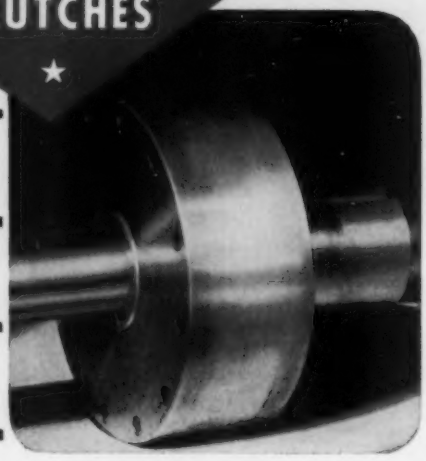
FOR POWER CONTROL DESIGNS USE
HILLIARD
Over-Running
CLUTCHES
★

1 LONG LIFE because the rolls have no localized wear points.

2 NO JAMMING even after long wear.

3 ACCURATE because of individual spring pressure on each roll.

4 RENEWABLE CAM SURFACES for increased life without machining or new parts.



50 YEARS of satisfactory service proves you can depend on Hilliard Over-Running Clutches and Couplings for long service on—

- DUAL DRIVES for pumps, fans, blowers and boiler stokers. (Many installations have a record of over 20 years without repair.)
- TWO SPEED DRIVES for dry cleaning machines, laundry equipment, conveyors, paper processing machines, slitters, forming rolls and automatic machinery.
- RATCHET ACTION for printing press ink rolls, coal feeders, press feeds, honing machines, bakery equipment and conveyors.
- BACK STOP SERVICE on textile machines, speed reducers, elevating conveyors and in combination with ratchet feeds.
- WRITE TODAY FOR BULLETIN 231 WITH COMPLETE INFORMATION.

OTHER HILLIARD CLUTCHES:

SINGLE REVOLUTION CLUTCHES for automatic accurate control—electrical or mechanical—of intermittent motion, indexing, cycling and cut-off. Ask for Bulletin 239.

SLIP CLUTCHES for overload protection, or constant torque and to provide constant tension and permit speed variation on rewind stands. Ask for Bulletin 300.

HILLIARD - TWIFLEX CENTRIFUGAL COUPLING for smooth, easy starting of any load automatically with overload protection and ability to accommodate shaft misalignment. Ask for Bulletin CE-3.

★ *CONSIDER AUTOMATION-INVESTIGATE THESE PRODUCTS*

THE HILLIARD Corporation

101 W. Fourth St., Elmira, N. Y.

IN CANADA: UPTON • BRADEEN • JAMES, LTD.

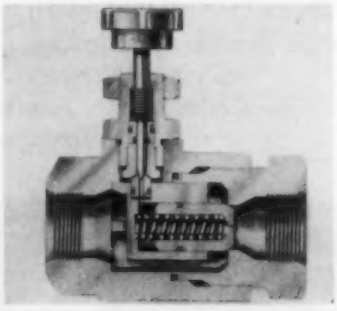
to be less than 10 gm, independent of second stage load. Flow rate is linear to 15 gpm at 0.030 stroke for 1000-psi drop; leakage, at neutral, less than 12 cu in./min. The ¼-in. tube-size hardened male fittings contain integral filter screens. Stainless steel valve weighs 16 oz. Unit reported to have successfully completed qualification tests demonstrating 1-million-plus cycle life at operating temperatures from —65 to 450 F. About $475 for standard valve. **Consolidated Controls Corp, 750 S Isis Ave, Inglewood, Calif.**

Circle 21, Reader Service Card

Magnetic disk brakes...

are self-adjusting for wear. Brakes, rated 125 through 575 lb-ft torque, are for C-flange motor mounting on frames 324 UC through 505 C or for foot mounting. Said to have high thermal capacity, which means that combination brake-motors are available for high-inertia loads or high-frequency starts and stops. Unit also has automatic reset manual release, standard length NEMA shaft extension for hub mounting, heavy-duty disks, taper-lock hub, ac and dc coil energization, standard and protected enclosures. For continuous duty operation. **Dings Brakes, Inc, 4740 W Electric Ave, Milwaukee 46.**

Circle 22, Reader Service Card



Hydraulic shutoff valve...

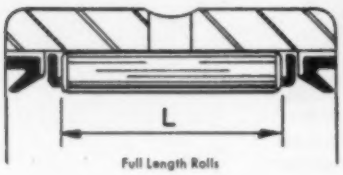
controls circuits to 5000 psi in applications where liquid is not subject to reversals of flow. In operation, valve is seated by back-

(Continued on page 121)

More Load Capacity! More Design Flexibility!

ORANGE SEALED *Cage Type* NEEDLE BEARINGS

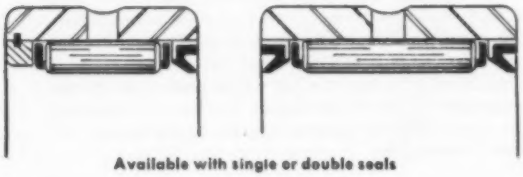
Longer Rolls—Higher Capacity



Full Length Rolls

Only Orange construction provides effective sealing without reducing roll length or load carrying capacity. Note the proportion of roll length to race, compared with other types. You get the full load capacity of Orange Cage Type Needle Bearings—plus the economy and efficiency of built-in Neoprene seals to keep dirt out and lubricant in.

TWO Bearing Lengths for Design Flexibility



Available with single or double seals

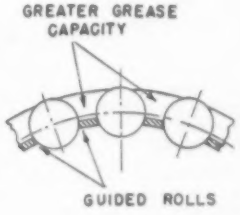
Only Orange offers Sealed Cage Type Needle Bearings in TWO bearing lengths for each shaft diameter. Both bearing lengths have full-length rolls in proper proportion to race, providing maximum load-carrying capacity. Thus, you have greater flexibility in meeting load, space and design requirements. Other sealed needle bearings offer only one bearing length, with shorter rolls and less capacity.

Effective Seal Design →

This provides positive exclusion of foreign matter, retains lubricant and acts as a vent to prevent displacement of seal if additional lubrication is added through holes provided in races.

—plus advantages of Orange Cage Design

The Orange cage design assures constant contact with entire length of roll periphery to provide the ultimate in guided rolls and resistance to skewing. Adequate space around rolls provides exceptional capacity for lubrication.



•

Stocked in popular sizes from ½" to 2" shaft diameters. Other sizes will be added as volume requirements are established.

Write for engineering data and prices. Ask for 40-page Engineering Reference Manual showing all Orange Roller Bearings.

ORANGE ROLLER BEARINGS

ORANGE ROLLER BEARING CO., Inc.
551 Main Street, Orange, N. J.

Needle Bearings — Staggered Roller Bearings
Journal Roller Bearings — Thrust Roller Bearings
Cam Followers

Reject rate too high?

GET THE
MD Metallurgist
IN THE PICTURE

The MD man who calls on you is a competent salesman. He is part of an industry that has grown to serve a significant new technique of manufacture — fabrication of precision parts from powdered metals.

He is backed by a company which, for the past 42 years, has pioneered in the development of the right powders for the right job, and which has always considered that solving customers' problems is a fundamental obligation.

Our laboratory, built and completely equipped for customer service, is staffed by "MD Metallurgists" who have also grown up with the industry, and have contributed to its progress. This "plus value" is always available to MD customers. Your problems are our problems.

MD PRODUCTS

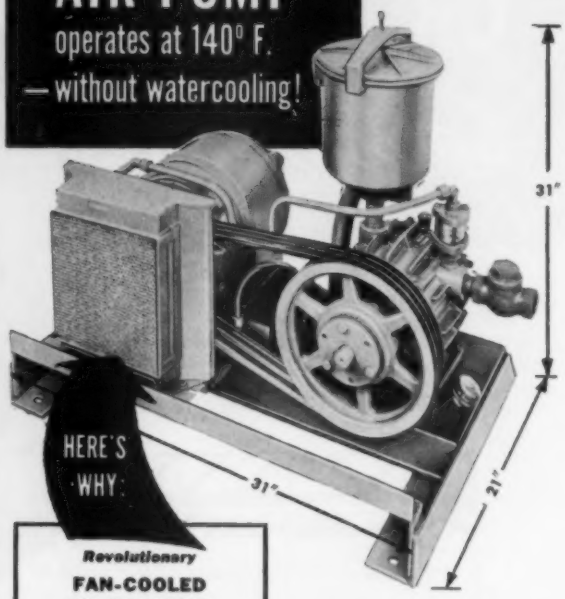
METALS DISINTEGRATING COMPANY, INC.
GENERAL OFFICES: Dept. N, Elizabeth 3, N. J.

LEIMAN ROTARY POSITIVE HIGH VACUUM AIR PUMP

operates at 140° F. — without watercooling!

VACUUM: to 29.9" Hg.

CAPACITY: to 40.8 c.f.m.



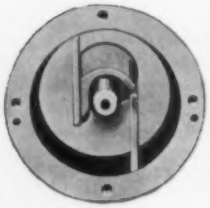
HERE'S WHY:

Revolutionary
FAN-COOLED OIL RADIATOR
(Patent Approved)

continuously circulates pre-cooled oil through pump, reduces heat on pump parts, prevents overheating and jamming. Oil provides seal for vacuum. Permits speeds up to 800 r.p.m., provides greater capacity with smaller pump.

- No water pipes—no leaks—place pump anywhere
- No oil vapor
- Rugged—for 24-hour continuous operation, without overheating
- Every pump performance-tested before shipment

You don't need bulky, high-priced air pumps and complicated water pipe hookups to produce continuous high vacuum. Leiman engineers have the answer in a compact package . . . the oil-cooled Leiman High Vacuum Pump. Run it 24 hours a day—it maintains an average temperature of 140° F. Run it year after year—it maintains fully rated capacity, without troubles or shutdowns, because it features the



"Lifetime" Leiman 2-Wing Vacuum Pump with Patented Wing Adjuster

Precision-honed cylinder walls are made of durable cast iron; wings are made of wear-resistant steel (not composition). Automatic wing adjuster assures constant wing-to-wall contact, prevents sticking or binding. Pump takes up its own wear to provide maximum vacuum for years.

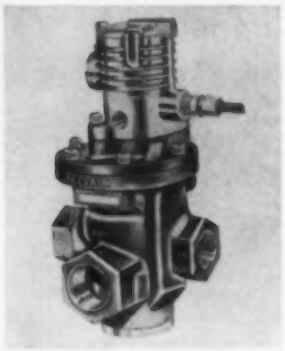
WRITE for latest 16-page catalog describing complete line of Leiman Vacuum Pumps, plus Application Book of "how-to-do-it" blueprints.

LEIMAN BROS, Inc.

107 Christie St. Newark 5, N. J.
Established 1887

pressure in balancing pressure chamber. Actuating pilot causes an unbalanced condition, which opens valve to practically unrestricted through-flow. Pilot operates by a single turn of a handle having less than 10 in.-lb torque or remotely controlled by 50- to 150-psi air-operated diaphragm or direct-acting solenoid. Pilot controls are external and interchangeable on same size body. Standard valve body is aluminum alloy; internal parts, stainless steel. Sizes range from ½ to 2 in., with female pipe threads or internal straight threads for O-ring seals. Operates in temperatures of —65 to 200 F. **Republic Mfg Co, 15655 Brookpark Rd, Cleveland 35.**

Circle 23, Reader Service Card



In-line control valve . . .

is poppet-type, with solenoid pilot designed for external supply, independent from line pressure controlled by valve. For high-speed operations where main operating pressure is below 20 psi, where valve is controlling vacuum to within 1 in. Hg absolute, or where pressure is reduced below 20 psi for machine setup. Poppet is air-cushioned. Corrosion resistance is provided by cast Navy M bronze body, stainless steel moving parts, and Hycar sealing materials. Two or three-way types, NC or NO, in sizes from ¼ to 1¼ in. NPT are offered. Solenoid pilot coils are available for ac or dc, any voltage. **Valvair Corp, 454 Morgan Ave, Akron 11, Ohio.**

Circle 24, Reader Service Card

Directional valves . . .

offer nominal ratings from 5 to 25 gpm and up to 6-spool configuration. Designed for operating pressures to 2000-psi oil. Open-center parallel-circuit design permits independent or simultaneous operation of cylinders or hydraulic motors. Multiple cylinders and hydraulic motors can be operated from a single, multispool unit. Valves are actuated through a lever control. Double-acting, single-acting and float spools have metering notches for precise load positioning, holding, raising or lower-

(Continued on page 124)

No. 3 of a Series

GRIPPING STORIES
from the files of Angier Adhesives

The Case of the BAFFLED DESIGNER

It was a tough job and "Rush", but now he had it licked. All he needed was the adhesive that would join the rubber component to the metal base. "No problem here," he thought, as he specified the rubber-to-metal formula that had been so successful in a previous job.

But there *was* a problem and it became more and more apparent as one after another of the trial bondings failed.

Once on the case, an Angier man unravelled the mystery in short order. He pointed out slight—*but important*—differences between the old product and the new—in rubber compound used, in end-product vibration and in heat and stress factors involved. He recommended an adhesive that was perfect in every respect and the designer met his deadline with two days to spare.

Turn to Angier *first* for job-tailored adhesives that are developed, tested and produced *by experts* to give you the most efficient product for every job at the lowest price per end-product unit.

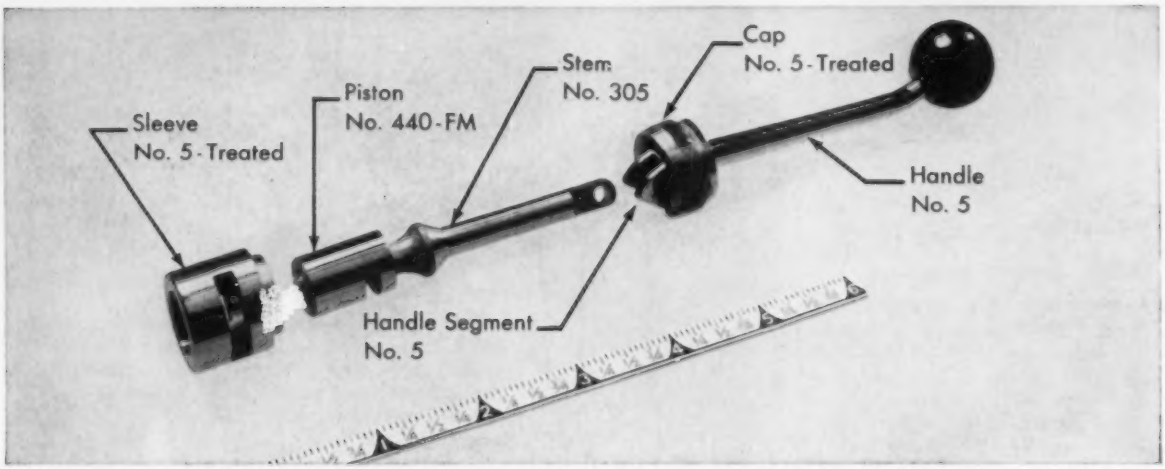
Call or write today *for complete information.*

ANGIER ADHESIVES

INTERCHEMICAL CORPORATION
Finishes Division
120 Potter St., Cambridge 42, Mass.
Midwestern Plant: HUNTINGTON, IND.

for strength, corrosion resistance and sales appeal

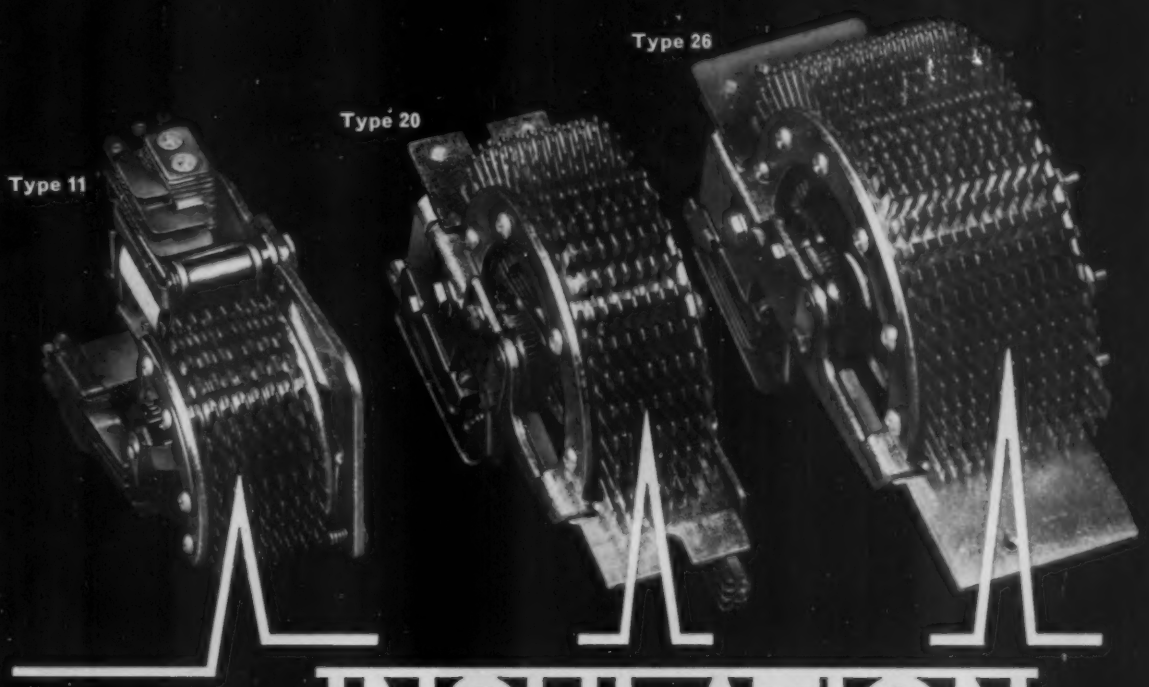
...it had to be Stainless



In this new one-handle mixing faucet all the important working parts are made of wear-resistant, corrosion-proof Carpenter stainless steels. Once you select stainless steel by Carpenter, you can forget about corrosion. You can design for high stresses, disregard maintenance problems, stop worrying about temperature variations and be assured that fabrication will be easy. And you not only get the help of consumer-acceptance of stainless products, but also the long experience of Carpenter. From the lab work through final production, Carpenter staffmen have the knowledge and the data. Call your Carpenter representative for the engineering information on stainless that you need. The Carpenter Steel Company, 117 W. Bern Street, Reading, Pa.

Carpenter STEEL

The Carpenter Steel Company, Main Office and Mills, Reading, Pa.
Alloy Tube Division, Union, N. J.
Carpenter Steel of New England, Inc., Bridgeport, Conn.
Webb Wire Division, New Brunswick, N. J.



NEW BLUE INSULATION

adds another refinement to CLARE Springdriven Stepping Switches

STANDARD AT NO EXTRA COST

CONSIDER

what these Superior Features will do for YOU !

- ***HIGH INSULATION RESISTANCE***

  100,000 megohms minimum between switch points and between each point and frame.

- ***STABLE INSULATION RESISTANCE***

  Maintains 100,000 megohms minimum resistance over temperature range from —55°C to +85°C.

- ***LOW MOISTURE ABSORPTION***

  Maintains low leakage characteristics in humid environment. Water absorption: 48 hours at 50°C, 0.5% (ASTM Test D570).

- ***GOOD ARC RESISTANCE***

  Endures arcing from wiper contacts, maintaining high resistance to dielectric breakdown. Arc resistance: 140 seconds (ASTM Test D495).

- ***MECHANICAL STRENGTH & STABILITY***

  High tensile and compression strengths. Holds mechanical dimensions throughout age and temperature variations (vital to retention of stack tightness.) Lifetime shrinkage: approximately .001 in./in.

- ***MEETS MIL SPECIFICATIONS***

  MIL—P—14D (Type MDG)
  MIL—P—4389 (USAF)

This new Blue Insulation supplied as standard on all CLARE *Springdriven Stepping Switches as soon as present stocks of Bakelite insulators are used up. No extra cost.*

Find out the many other superior qualities of CLARE *Springdriven Stepping Switches. Call or write: C. P. Clare & Co., 3101 Pratt Blvd., Chicago 45, Illinois. In Canada: C. P. Clare Canada Ltd., 2700 Jane Street, Toronto 15. Cable Address:* CLARELAY.

Send for CLARE Engineering Bulletin #101

CLARE RELAYS

FIRST in the industrial field

MORE POWER...

GREATER EFFICIENCY...

HIGHER POWER FACTOR!

BALDOR

Streamcooled

MOTORS

BALTRIC LINE

For general use or for specific applications demanding the most exacting requirements, the Baltric line of motors more than fills the bill. One reason is the "Monocast" Stator shown above.

Steel laminations in an aluminum alloy casting form a stator frame of greater stability . . . greater rigidity. This permits the use of a new and better slot design. The result is uniform magnetic flux distribution throughout the motor—gives more power, greater efficiency, higher power factor and quieter operation.

If you're interested in getting top efficiency from your equipment while holding costs to a minimum, investigate the Baltric line of motors—without obligation! Just write . . .

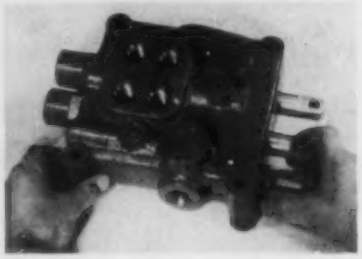
BALDOR

ELECTRIC COMPANY

4351 Duncan Avenue • St. Louis 10, Missouri

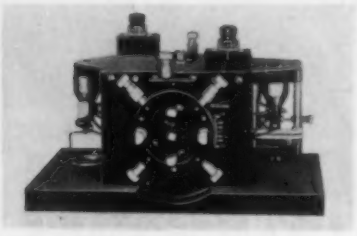
Over 500 Authorized Sales & Service Distributors in U. S. A.

District Offices: Atlanta • Chicago • Cleveland • Dallas • Dayton • Des Moines • Detroit • Litchfield, Conn. Los Angeles • Milwaukee • Minneapolis • New Orleans • New York • Kansas City, Mo. Oakland • Philadelphia • Portland, Ore. • Syracuse.



ing operations and for control of hydraulic motor operation. Differential relief valve is externally adjustable. Ports are machined with SAE straight thread O-ring connections. Inlet and outlet ports may be 90° or 180° apart. Ports on standard valves are located on either side of body, opposite each other. **Wooster Div, Borg-Warner Corp, Bedford, Ohio.**

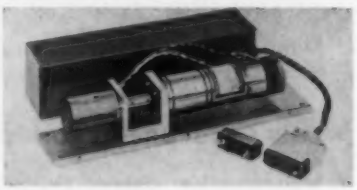
Circle 25, Reader Service Card



Torque balance . . .

measures reactance and stall torques of small motors. Crossed-reed flexure pivot with threshold of 0.05 dyne-cm is said to provide accuracy within 0.3% + 0.05 dyne-cm. Balance has direct-reading ranges of 0.05 to 2; 2 to 1000; and 1000 to 100,000 dyne-cm using a 10-times multiplier. Electrical circuit components include a preamplifier and amplifier, ring-type phase-sensitive demodulator and potentiometer circuit. Device consists of two units that measure 4 x 2 x 2 ft deep and 2 x 2 x 1½ ft deep, over-all. **Eder Engineering Co, 1568 S First St., Milwaukee 4.**

Circle 26, Reader Service Card



Servo positioner . . .

is now available as a unit, with components varying to meet performance requirements. This assembly uses motor-generator for 115-v, 400-cps operation. Stall torque is rated at 0.63 oz-in. Motor

(Continued on page 129)

if **BRAKES** are your problem

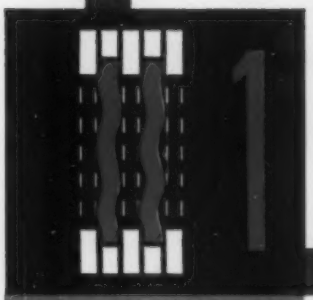
let's talk

Maxitorq

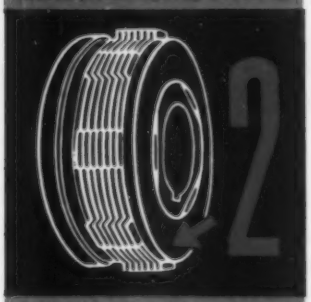
the floating disc clutch that is equally efficient as a **BRAKE**

Single

Double



Unique separator springs completely separate floating discs when in neutral, preventing drag or heating.



Locking plates hold discs and separator springs in correct and complete assembly. Easily installed, easily serviced.

Simple manual adjustment by rotating this locked ring. Requires no special tools.

Here is a practical and efficient answer to the majority of brake problems in machine tool and industrial machinery drives, because the service-proved advantages of MAXITORQ Floating Disc design apply equally to the use of these dependable units *either as clutches or brakes.*

These advantages include compact, simple and rugged construction, ideally suited to "designed-in" applications. With patented MAXITORQ separator spring design, engagement and disengagement is always positive and complete, with no drag or heating in neutral. MAXITORQ Brake or Clutch Units are furnished complete, ready to install, with simple manual adjustment—no special tools required.
Can be used either WET or DRY and assure long, trouble-free service. Let our Engineering Department help you solve either BRAKE or CLUTCH problems this proved way.
Send us an outline of your needs. Write Dept. PE-9.

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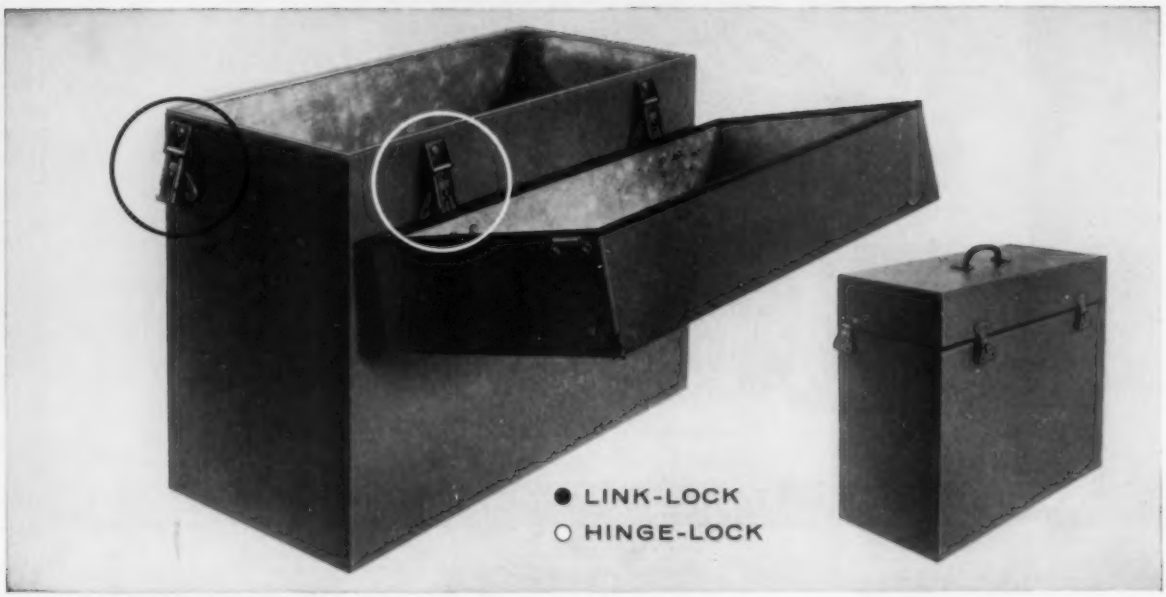
SC-J59

Now

An all-around pressure-tight seal for hinged-cover transit cases with

LINK-LOCK and HINGE-LOCK



No. 3 LINK-LOCK

No. 3 HINGE-LOCK

Two HINGE-LOCK and two LINK-LOCK Fasteners provide all-around sealing pressure on this container manufactured for the U.S. Navy by the Bonded Structures Division, Swedlow Plastics Company.

The new Simmons HINGE-LOCK, used in combination with LINK-LOCK, provides an even, pressure-tight seal on equipment containers and transit cases with hinged covers. A half-turn applies pressure to both types of fasteners. When pressure is released HINGE-LOCK becomes a free-operating hinge, and LINK-LOCK disengages to permit opening.

Originally developed by Simmons Fastener Corp. for the Engineering Department of Swedlow Plastics Company, Bonded Structures Division, HINGE-LOCK is similar in principle and appearance to LINK-LOCK. Both are available in light and medium duty sizes as matched hardware. LINK-LOCK is also available in a higher-capacity, heavy-duty size.

SEND TODAY for complete data, including dimensions, capacities. Engineering service is available... Outline your requirements. Samples on request.

See our 8 page catalog in Sweet's 1958 Product Design File

SIMMONS FASTENER CORPORATION 1751 North Broadway, Albany 1, New York

QUICK-LOCK • SPRING-LOCK • LINK-LOCK • HINGE-LOCK • ROTO-LOCK • DUAL-LOCK

New Bastian-Blessing handle (shown at right) **is delivered by Chase Brass in multiple lengths, to avoid waste in cutting.** (Note contrast with old handle.)

Ask Bastian-Blessing

How to get new product appeal and easier manufacture

Bastian-Blessing Company has for years made a complete line of welding torches. On one of their models they used a regular brass tube which was knurled during the manufacturing process. To increase the attractiveness of this torch and minimize production problems—they developed the idea of a fluted tube.

The customer wanted a mill-drawn surface which would need no further finishing—except scratch brushing. Flute spacing had to be kept regular; interior diameter had to hold vital concentricity. The Bastian-Blessing Company in cooperation with Chase Brass & Copper Co. was able to achieve their objectives:

- **Better style—more eye-appeal.**
- **A much more comfortable and easier-gripped handle.**
- **Improved machineability.**
- **A more rugged product than before.**

PLUS—costs kept in line with the old handle!

Whatever product you design or make, chances are you can do it better with Chase Brass—alloyed from copper by Kennecott. Your nearest Chase Representative is ready to discuss your needs with you. You can reach him locally or by writing Waterbury 20, Connecticut.

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Kennecott Copper Corporation

The Nation's Headquarters for Brass, Copper and Stainless Steel

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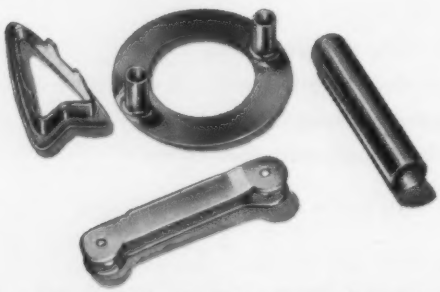
put your finger on PROFIT

This magnified minuscule electrical part is another Advance Stamping which saved production costs.

Yes—*bigger profits* from *smaller parts* are very possible when you engineer in Stampings—especially *Advance Stampings.* As Specialists in Small Stampings, Advance has been helping metal working industries of various kinds attain higher production at lower cost for over 35 years.



Here are typical Advance Stampings which have been fabricated in different materials to meet tolerance specifications, delivery and price.

Send us your blue prints or samples for quotations. Advance engineers are available to consult on ways to improve your competitive position.

Write for Small Stamping Specialists Brochure

ADVANCE STAMPING CO.

12029 Dixie Ave., Detroit 39, Michigan

128 CIRCLE 183 READER SERVICE CARD

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Step up the man-hour factor of your equipment with job-fitted Milsco Contour cushion seating. "Body-Form" design is a Milsco exclusive, the result of many years experience, research, design and manufacture of heavy duty seating for all types of mobile equipment. Write us about your seating problem.

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Solid attachment or exclusive "tip-up" attachment for limited space access are available on the Milsco PIONEER.

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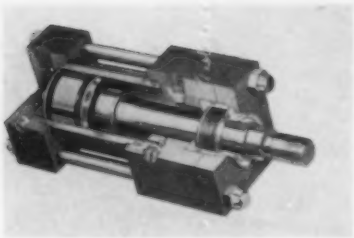
CIRCLE 184 READER SERVICE CARD

power input is 4 w; generator takes 3.6 w. Voltage output is handled by potentiometer with total resistance to 10,000 ohm ±5% and a linearity tolerance of ±0.05%. Damage to potentiometer from system is prevented by a gearhead clutch that slips at 20 oz-in. and potentiometer stops that can take to 50 oz-in. Applications include balancing, positioning and computing servos or anywhere that an electrical output corresponding to shaft input is desired. **Helipot Div, Beckman Instruments, Inc, Newport Beach, Calif.**

Circle 27, Reader Service Card



Square head cylinders . . .

for class 3 hydraulic use to 3000 psi are now available in 19 basic mountings, or models, and bore sizes from 1¼ through 12 in. Cylinder has expansion-type tube seal that is said to prevent extrusion at exclusive shock pressures. Positively locked, one-piece concentric piston uses self-compensating U-cup seals. Multiple V-ring rod seal is spring-loaded. **Galland-Henning, Nopak Div, Milwaukee.**

Circle 28, Reader Service Card

Aluminum carrying case . . .

for drawings, plans and blueprints is offered in three standard sizes, accommodates rolled subjects to 60 in. Case is 3 in. dia. Made of 16-gage aluminum alloy and equipped with a leather grip handle and steel hasp for padlock. **Scott-Rice Co., 610 S Main, Tulsa, Okla.**

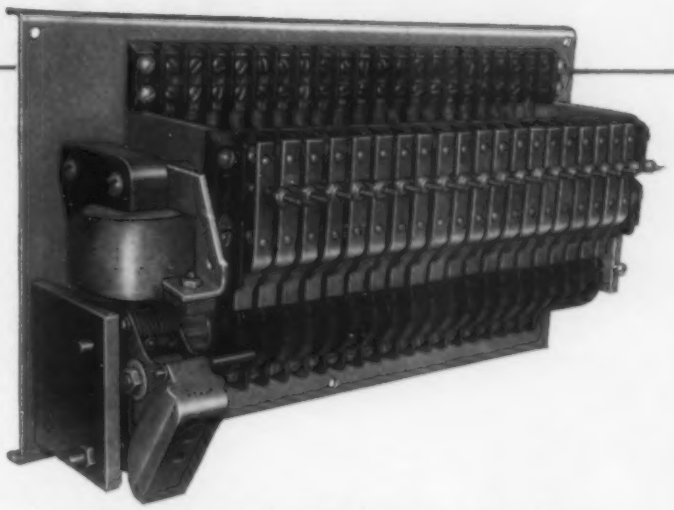
Circle 29, Reader Service Card

X-Y track drafting machine . . .

provides graduated track setting in addition to the usual angular and dimensional measurements possible with drafting machine protractor and scales. Graduations divide the entire drawing area into a 10-in. grid pattern. Glides horizontally and vertically. Unit has protractor with full 360° visibility and graduations, automatic 15° index stops, baseline selector, ball-bearing indexing head and engine-divided horizontal and vertical scales. From stock to fit standard drawing boards and L-tables. **Universal Drafting Machine Corp, 7960 Lorain Ave, Cleveland 2.**

Circle 30, Reader Service Card

NEW EAGLE STEP SWITCH offers a special approach to automatic process control step sequencing



Development of the Eagle step switch now provides a new approach to process control. Any type of time or sensing device can be used to advance the switch, and a multiplicity of load circuits can be operated in any combination — up to 19 circuits. Devices used to actuate the switch include: push buttons, limit switches, timer intervals, pressure change components, level control apparatus.

The new switch also provides a sequencing interlock when used with multiple indexing circuits. A mechanical circuit interlock by cam action eliminates interlocking relays. Ten ampere switch contacts control load switches direct — no need for load relays. Switch is built with 115 volt coil, and is of heavy duty industrial switch construction throughout.

Make certain you get complete information on this new switch. Send for Bulletin 780. Eagle Signal Corporation, Dept. PD-958, Moline, Illinois.

For Rolls... Specify

Versatile ACIPCO CENTRIFUGALLY SPUN STEEL TUBES

BLAW-KNOX

Among the equipment Blaw-Knox Company manufactures for many industries are steel mill roll-out tables. ACIPCO tubes, furnished as cast, 12.43" OD x 9.50" ID, machine cut to 4-ft. lengths, are used as rolls in this Blaw-Knox table.

Because they are centrifugally spun, ACIPCO tubes are dimensionally stable and possess an inherent high degree of dynamic balance. Their dense, homogeneous, inclusion-free grain structure results in good machinability. In addition, ACIPCO tubes are highly resistant to impact, an important requirement for steel mill table rolls.

These advantages, plus the flexibility of ACIPCO's complete "one source—from start to finish" facilities, are reasons why Blaw-Knox specified ACIPCO centrifugally spun tubes for this application.

"Custom-spun" in stainless steel, all carbon steels or special analyses as well as in all alloy irons including Ductile, ACIPCO tubes are furnished to your exact physical, chemical and metallurgical specifications.

If rolls are a part of your products, or if you use tubular metal components in any way, get full information about ACIPCO. Call or write today.

One of the world's leading producers of complete mills and auxiliary equipment for rolling ferrous and nonferrous metals, Blaw-Knox Company also is a major supplier to the chemical, petroleum, food processing, construction and communications industries. The company has its headquarters in Pittsburgh, and manufacturing plants in Pittsburgh and Erie, Pa., Buffalo, Chicago, Mora, Minn., and Wheeling, W. Va.

VERSATILE ACIPCO TUBES

Size Range: Lengths up to 410" have been produced to meet modern machinery requirements. OD's from 2.25" to 50"; wall thicknesses from .25" to 4".

Analyses: All alloy grades in steel and cast iron, including heat and corrosion resistant stainless steel, plain carbon steel and special analyses.

Furnished: As cast, rough machined, or finished machined, including honing. Complete welding and machine shop facilities for fabrication.

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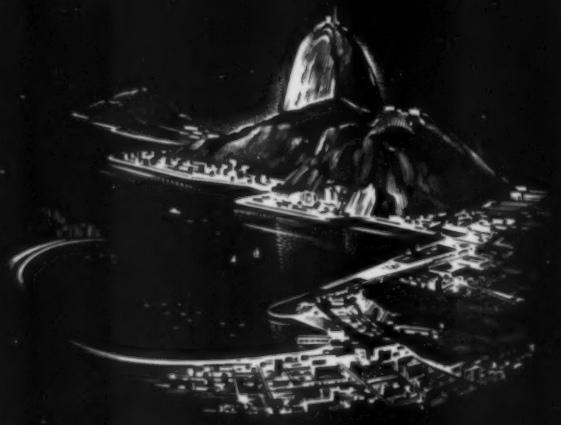
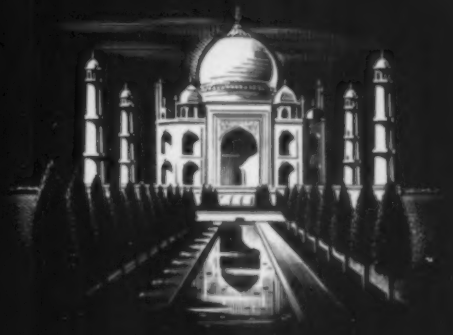
ACIPCO

No matter where your customers buy Macoma





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Shell Tellus Oils—for closed hydraulic systems

Shell Alvania Grease—multi-purpose industrial grease

Shell Turbo Oils—for utility, industrial and marine turbines

Shell Rimula Oils—for heavy-duty diesel engines

Shell Talona R Oil 40—anti-wear crankcase oil for diesel locomotives

Shell Dromus Oils—soluble cutting oils for high-production metal working

Shell Voluta Oils—for high-speed quenching with maximum stability

Its performance and name are the same around the world

Shell Macoma Oils are premium quality, fortified extreme pressure gear oils. They provide superior high-load-carrying capacity and are particularly effective where overloading, severe shock-loading or general heavy-duty conditions exist.

Macoma* Oils have these added built-in benefits: excellent resistance to oxidation, great adhesiveness, rapid separation from water. They are non-corrosive, non-foaming and have high stability in storage.

The world-wide availability of Macoma Oils is assurance that your customers abroad will get the same performance from your equipment that your domestic customers rely upon. For complete specifications, write Shell Oil Company, 50 West 50th St., New York 20, N. Y. or 100 Bush St., San Francisco 6, California.

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adds new sales appeal to your appliances

Just look at the features below! They will give you an idea of how the specially engineered construction of HPN Coiled Cords leads to consumer benefits that add to the visible sales appeal of your appliance. Better yet, get in touch with your Cords Ltd. product application engineer and see for yourself. Call today.

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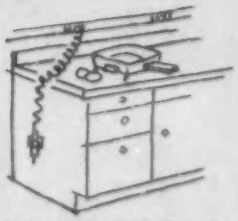
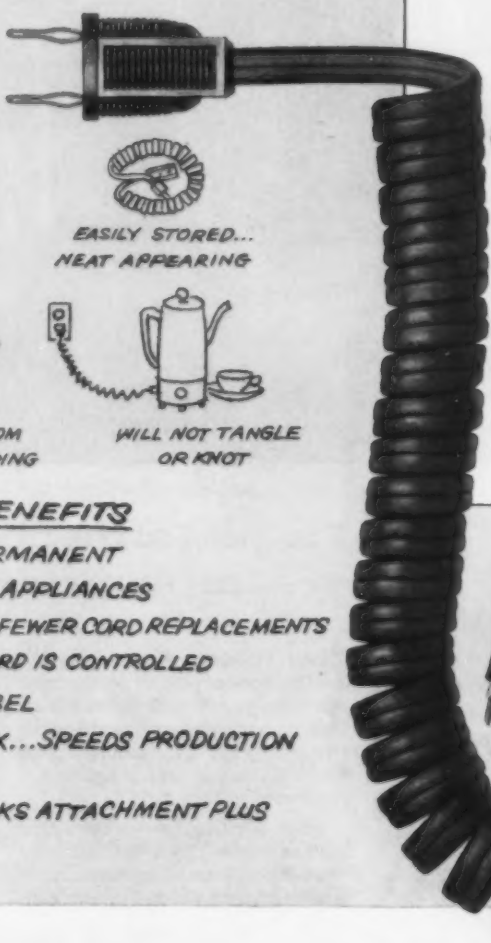
APPLIANCES REMAIN STATIONARY



HOLDS THERMOSTAT IN SUSPENSION IF DROPPED



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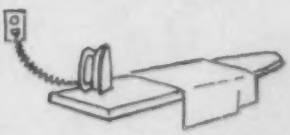
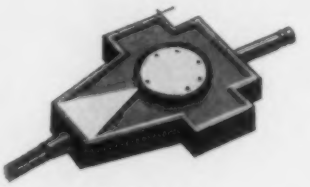
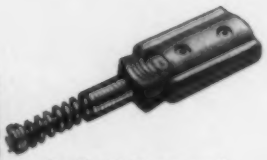


IS SAFE... DOES NOT HANG FROM WORK AREA... PREVENTS TRIPPING

WILL NOT TANGLE OR KNOT



For New Heat Probe



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ADDITIONAL BENEFITS

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CORDS LIMITED
Division

Essex Wire Corporation, DeKalb, Illinois

CATALOGS and BULLETINS

To obtain copies of literature described below, circle corresponding number on postcard inside back cover.

RELAYS AND SWITCHES – Catalog 4071-J, 100 pp. Contains general reference data and specifications for full line of telephone-type relays and rotary stepping switches for industrial control applications. Automatic Electric Sales Corp, Northlake, Ill.

Circle 31, Reader Service Card

PHOTOELECTRIC CONTROL SYSTEMS–Bulletin PA-561, 24 pp. Describes photoelectric systems for industrial control applications, miniature and subminiature photoelectric receivers, and light sources for control application, with specifications and operational charts. Includes selector guide. Electronics Corp of America, Photoswitch Div, 1 Memorial Dr, Cambridge, Mass.

Circle 32, Reader Service Card

STAINLESS STEELS–Brochure, 32 pp. Describes physical properties and analyses, corrosion and heat resistance, surface finishes, fabrication, maintenance and ability to be cleansed of bacteria for all special-purpose sheet and strip grades. Washington Steel Corp, Washington, Penna.

Circle 33, Reader Service Card

HEAVY-DUTY COIL SPRINGS–Handbook, 48 pp. Includes mathematical data, charts and design information applicable to development of coil springs. Also reviews facilities for manufacture of springs. Crucible Steel Co of America, Spring Div, Box 2518, Pittsburgh 30.

Circle 34, Reader Service Card

STANDARD ELECTRONIC HARDWARE–Reference manual, 75 pp. Lists more than 100 different types of standard parts available from stock in thousands of sizes. With pictures, diagrams, dimensions. Reference data, such as physical properties of elements, properties of rubber, atmospheric table, temperature conversion and conversion factors, is tabulated. Amatom Electronic Hardware Co, Inc, 88 Drake Ave, New Rochelle, N Y.

Circle 35, Reader Service Card

STRAIGHT-THREADED PORT FITTINGS–Catalog M-58, 4 pp. Describes metal-to-metal seal, straight-thread hydraulic fitting. Gives specs and installation instructions. Flodar Corp, 16911 St Clair Ave, Cleveland 10.

Circle 36, Reader Service Card

CENTRIFUGAL PUMPS–Bulletins HY-558 and IH-558, 12 pp each. Selection tables for 1531 and 1510 Series pumps, respectively. Describes operational features, construction. Gives dimensions and specifications. Bell & Gossett Co, 8200 N Austin Ave, Morton Grove, Ill.

Circle 37, Reader Service Card

VARIABLE-SPEED DRIVES – Bulletin D-2506, 16 pp. Describes operation and application of drives. Graphically covers manufacture and functions of drive components. Also lists condensed drive specs, dimensions and accessories. Reliance Electric and Engineering Co, 24701 Euclid Ave, Cleveland 17.

Circle 38, Reader Service Card

PNEUMATIC EQUIPMENT – Catalog 157, 20 pp. Presents line of automatic moisture separators, lubricators, regulators, filters for compressed air systems. Discusses applications and operation of each. Wilkerson Corp, 1656 W Girard Ave, Englewood, Colo.

Circle 39, Reader Service Card

BAROMETRIC CONDENSERS – Bulletin 5AA, 12 pp. Covers condenser theory, design features, construction, operation and application. Performance data is given in curves. Tables list sizes, dimensions and weights for units described. Sectional drawings are used to illustrate equipment and explain operation. Dept JA-13, Schutte and Koerting Co, Cornwells Heights, Penna.

Circle 40, Reader Service Card

MECHANICAL TUBING–Data folder TB-428, 4 pp. Explains how smooth inner diameter welded carbon steel tubing is produced. Includes tables for microinch finish. Discusses ultrasonic inspection technique. Tubular Products Div, Babcock & Wilcox Co, Beaver Falls, Penna.

Circle 41, Reader Service Card

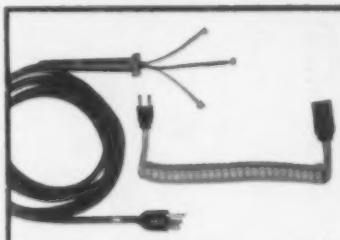
MERCURY SWITCHES–Brochure, 4 pp. Describes 12 styles for standard and heavy-duty applications. Gives specs and dimensions. American Designed Components, Inc, Jericho, N. Y.

Circle 42, Reader Service Card

SPEED REDUCERS – Catalog, 4 pp. Presents size range and styles available in tabular form. Alten Foundry and Ma-

(Continued on page 134)

They can be your design assistants on other Essex Engineered Products.



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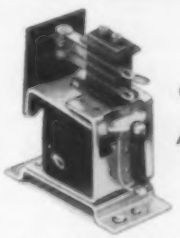

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The basic relay and numerous contact forms, ratings and terminals variations are regular production items...have been "customerized" to solve almost every conceivable problem. Such versatility permits engineering short-cuts that lower your "back door" cost.

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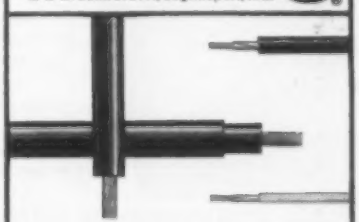
R-B-M Control Div., Logansport, Ind.



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A complete line of appliance wiring material, radio, television and electronic hook-up wire, 200°C high temperature Sil-X wire, automotive wires and cables, and flexible cords.

Wire and Cable Div., Ft. Wayne, Ind.

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PREMIUM GEARING
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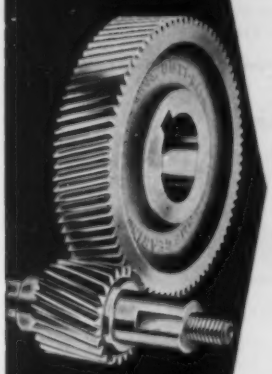
Foote Bros. Offers Engineered Helical and Worm Gear Sets FROM STOCK

1638 Duti-Rated COMBINATIONS



IN STOCK:

*Horsepower Ratings....1 to 200**
*Center Distances.....2" to 12"**

Check with Foote Bros. *before* you finalize that design. The chances are you'll find exactly what you need among the 1638 *stock* combinations of Duti-Rated Helical Gears.

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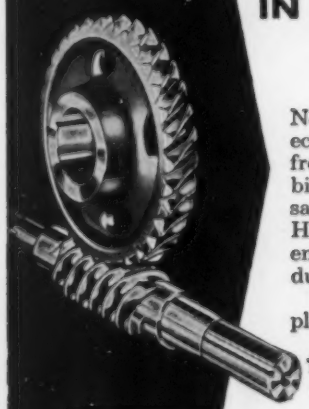
Write for DUTI-RATED catalog: Engineering Manual DR No. 2.

150 WORM GEAR COMBINATIONS



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chine Works, Inc, W Wheeling St, Lancaster, Ohio.

Circle 43, Reader Service Card

FERROUS CASTINGS—Folder 17, 4 pp. Surveys types of iron and steel castings produced. Chart compares physical properties, machining quality and other characteristics of various types of castings. Discusses factors influencing design and cost. Belle City Malleable Iron Co—Racine Steel Castings Co, Racine, Wis.

Circle 44, Reader Service Card

CASTERS—Catalog, 6 pp. Illustrates six casters in 3100 Series with specs, photos, drawings and applications. Describes design and assembly features. Rapids-Standard Co, Inc, 342 Rapistan Bldg, Grand Rapids 2, Mich.

Circle 45, Reader Service Card

FLOW REGULATORS—Catalog 1000, 16 pp. Includes specs, dimensional drawings and sectional illustrations for pressure-compensated flow regulators for hydraulic power systems. An orifice-flow chart and other performance data is also given. Waterman Engineering Co, 725 Custer Ave, Evanston, Ill.

Circle 46, Reader Service Card

METAL SPECIFICATIONS AND PRACTICES IN THE US—Booklet, 16 pp. Summarizes lecture material presented by Roger Waindle, president of this company, to 1958 meeting of European Investment Casters Assn. Graphs, photomicrographs and electron micrographs are used. Waimet Alloys Co, 1999 Guoin St, Detroit 7.

Circle 47, Reader Service Card

HARD-RUBBER PIPE FITTINGS AND VALVES—Bulletin PF-1300, 8 pp. Discusses characteristics and handling of natural hard rubber and Buna-N synthetic. Physical properties of both are included. Also presents, with diagrams and dimensions, threaded fittings, check valves, petcocks, bibcocks and many types of valves. Luzerne Rubber Co, Trenton, N. J.

Circle 48, Reader Service Card

SELF-SEALING COUPLING—Engineering bulletin 17, 8 pp. Design and construction of coupling for 3000-psi aircraft hydraulic systems are explained and principles of operation illustrated. Includes dimensional data, list of accessories, and installation instructions. Aeroquip Corp, Jackson, Mich.

Circle 49, Reader Service Card

OIL FILTERS—Bulletin F-400, 4 pp. Describes full-flow filters and various cartridges. Data table makes selection of proper filter convenient. Cutaway views

(Continued on page 136)

PREVIOUS PROCEDURE

1 Drill bolt holes in "clip angles."

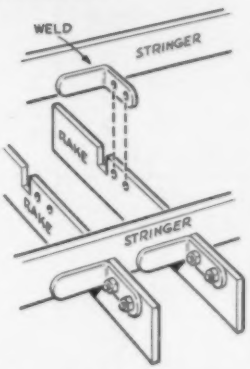
2 Weld clips to stringer.

3 Drill holes in rake blades.

4 Mill stringer slots in rake blades.

5 Bolt rakes to clip angles.

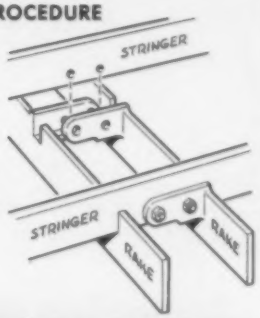
REPEAT FOR EACH BLADE

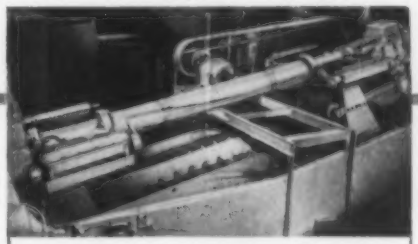


PRESENT PROCEDURE

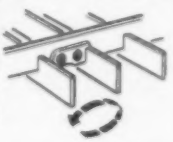
1 Drill bolt holes in stringer.

2 Bolt one-piece castings (complete with holes, slots, and flanges) IN RIGHT- AND LEFT-HAND PAIRS, to stringers.





Type H rake classifier made by Dorr-Oliver Inc., of Stamford, Conn., separates solids in liquid-solid mixtures into two fractions according to particle size. Fine materials overflow with liquid at lower end of inclined tank; larger particles settle to tank bottom, are continuously raked up inclined slope and discharged "over top." Rake blades move in oval track due to motion of rocker head, must be precisely aligned to move settled material up to next rake without either scraping or undue clearance.



Use of Cooper Alloy close-tolerance shell casting eliminates 3 out of 5 machining operations for Dorr-Oliver rake classifier blades, showing

How to Cut Fabrication Costs with Close-Tolerance Stainless Castings

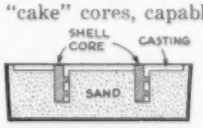
Previous method of attachment of rakes to stringers was by "clip angles" welded to stringers, drilled and bolted to simple flat blades themselves drilled and slotted as shown. Construction was expensive, and often unsatisfactory, in that heat of welding tended to put rakes out of alignment.

In redesigning, Dorr-Oliver decided to eliminate the clip angle as a separate third piece by incorporating it into the blade castings. Original conception was to cast rough slots and holes, then mill and drill them to dimensions. Cooper Alloy, after study of the piece, determined that with close-tolerance plastic shell cores, both bolt holes and stringer slots could be cast directly in the rake blade, without need of further machining. Also, that by using right- and left-hand patterns of rake flanges, *two* rake blades could be bolted to stringers with one set of bolts.

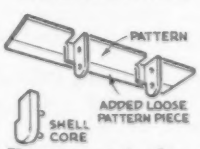
Casting requirements stringent

- Bolted face of each of the upright flanges required a smooth finish (250 A.S.A. Standard).
- 11/16" cored holes had to be smooth, accurate to ±.010", and precisely positioned for proper fitting of parts.
- Stringer slots had to be precisely positioned, accurate in dimensions to ±.025".
- Multiplicity of patterns for different widths of rake blades had to be reduced, for economy.

Casting solutions For the critical flange faces and bolt holes, shell "cake" cores, capable of holding precise dimensions down to ±.010", were prepared. They were inserted and became an integral part of the green-sand molds that formed the less critical outer blade areas.



CUTAWAY ELEVATION: ENTIRE PIECE IN DRAG.



To save cost of a complete new pattern for each rake size, all sizes of rake were designed to have the same blade thickness and flange dimensions. Patterns were then made of the narrowest-width blade in each series, loose pattern pieces being added to increase blade width of the larger rake sizes.

Results –"These rake blades", says Dorr-Oliver, "were used directly as cast, with no additional machining of any kind. Dimensions were precise, surfaces smooth, and finished alignment better than with previous 3-piece welded assembly. New procedure saves time and handling, and has reduced our manufacturing costs on this piece considerably."

Such economy possibilities are available in almost any shape, no matter how simple, or how "cut-and-dried". Cooper Alloy has specialized for 35 years in achieving such uncommon results in close-tolerance stainless steel castings, and can do the same for you.

To check on it, why not take advantage of our Foundry Engrg. Service? Just send us (without obligation) a blueprint or outline of your problem part, for cost analysis, to: Foundry Products Division, COOPER ALLOY CORPORATION, Hillside, N. J.

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4-pole, 4-coil shaded pole
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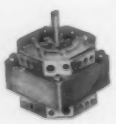

MODEL D
1/90 H.P. to 1/45 H.P. 4-pole, 4-coil shaded pole
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Circle 50, Reader Service Card

THERMOSTATS – Bulletins 5000 and 7000, 2 pp each. Covers operating principles and gives performance data, ratings, dimensions and construction details. Illustrated with schematics and photos. Bulletin 5000 covers unit that opens or closes low-wattage electrical circuit upon predetermined temperature increase. Bulletin 7000 covers bimetal-strip units for quick make and break of electrical circuits. Stevens Mfg Co, Inc, PO Box 1007, Mansfield, Ohio.

Circle 51, Reader Service Card

JOURNAL LUBRICATOR–Bulletin, 6 pp. Gives design, construction and installation information. Answers 16 questions about unit. Uni-Pak Corp, Box 8302, Pittsburgh 18.

Circle 52, Reader Service Card

POWER TRANSMISSION–Catalog 1A-58, 4 pp. Text and sketches cover right-angle bevel gear drive applications. Tables, drawings and graphs explain construction and performance of units. Airborne Accessories Corp, 1414 Chestnut Ave, Hillside 5, NJ

Circle 53, Reader Service Card

POWER REGULATION–Bulletin 101-L, 4 pp. Describes thyratron grid control and covers applications to motor and generator controls, regulated power supplies, servo systems and process control. VecTrol Engineering, Inc, PO Box 1089, Stamford, Conn.

Circle 54, Reader Service Card

BASIC SOLENOID VALVES–Bulletin 500-C, 4 pp. Pictures and describes basic units. Gives design features, specifications and characteristics. Illustrated with photos and schematic. J D Gould Co, 4707 Massachusetts Ave, Indianapolis 18.

Circle 55, Reader Service Card

ELECTRIC MONITORING SYSTEM –Bulletin 4.010, 2 pp. General description, applications and specifications are given. With schematics and dimensional drawings. Electric Regulator Corp, Pearl St, Norwalk, Conn.

Circle 56, Reader Service Card

LIQUID-LEVEL GAGES AND VALVES–Condensed catalog 335, 8 pp. Illustrates standard and special-function gages and valves, gives dimensional drawings, construction features, pressure-temperature graphs and ratings, materials, tables of sizes, specifications, and standard and optional features. Jerguson Gage & Valve Co, 80 Adams St, Burlington, Mass.

Circle 57, Reader Service Card

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Since we started making glass spheres in 1914, they've been used primarily for reflective paints. You see them in use in highway signs and in the road stripes that glow in the beam of your headlight. Now, with increased capacity, we are looking for new, different uses.

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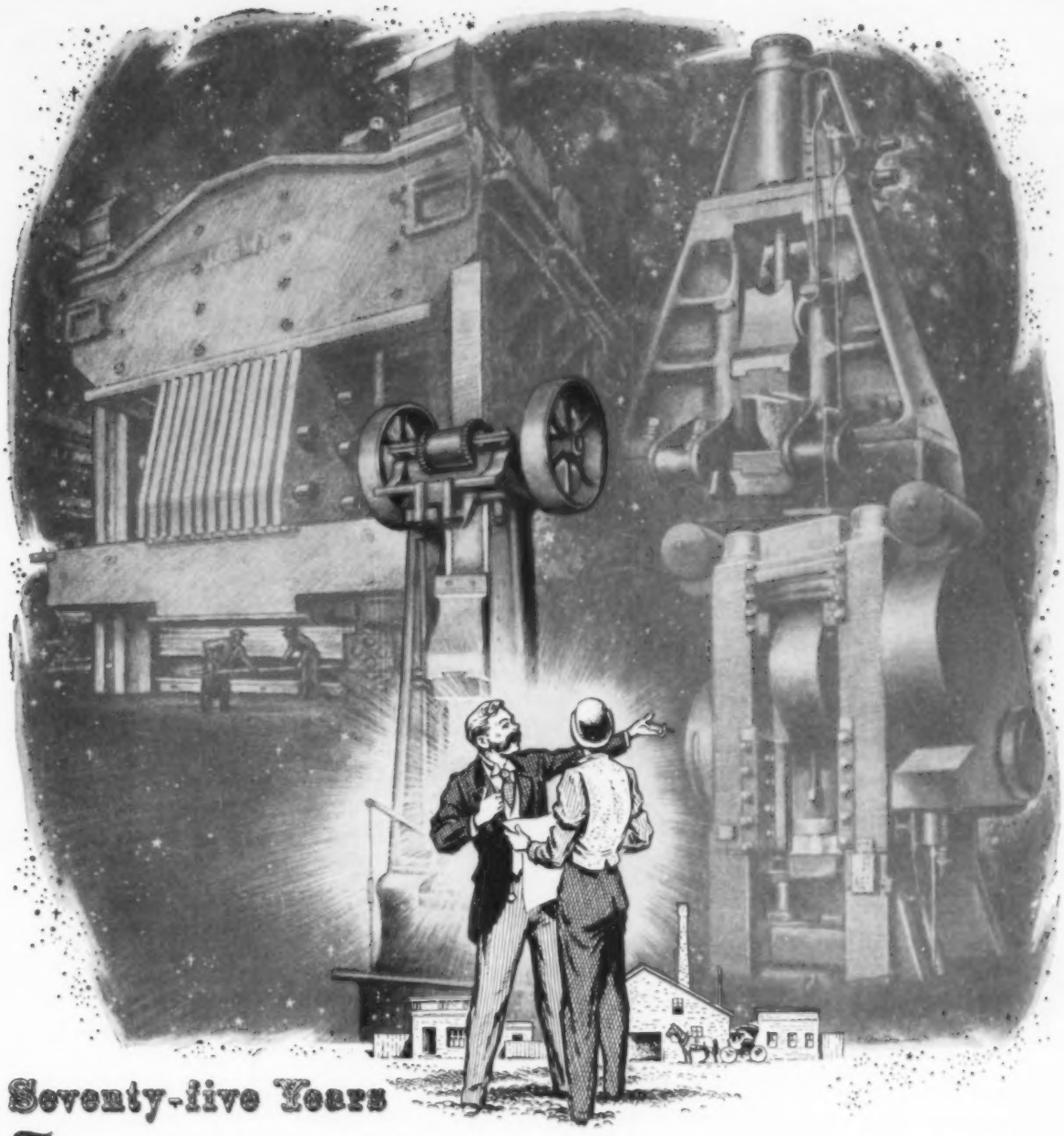
They are the most inexpensive spherical objects to our knowledge. We can even make them moisture resistant.

Do any of their properties suggest a use to you? Samples and all the data we have are yours on request.

POTTERS BROS. INC.

Carlstadt, N. J.



Seventy-five Years

THERE WAS a growing surplus in the United States Treasury—the Polygamy Act was passed—letter postage was reduced from three cents to two cents—the Brooklyn Bridge was opened—standard time was adopted—in 1883, when two young men, just graduated from Worcester Polytechnic Institute, established the business bearing their names—WYMAN-GORDON. The total capital was $27,000.

Integrity, initiative, ambition and ability were theirs. Endowed with these qualities and privileged to operate under that unique American system of free, private, competitive enterprise the Company prospered and grew.

On this our 75th anniversary, we salute the spirit of our founders and we pledge our every effort to help preserve, against the steady erosion of the last quarter century, that system which has made our nation what it is today and which has enabled us to build the greatest industrial production in the world, resulting in the highest standards for all segments of our people.

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Model CA3 Strain Gage Amplifier

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EXCITATION: 28 volts DC, ±5%
OUTPUT: 0-5 volts DC
FREQUENCY RESPONSE: Flat from 0 up to 2000 cps
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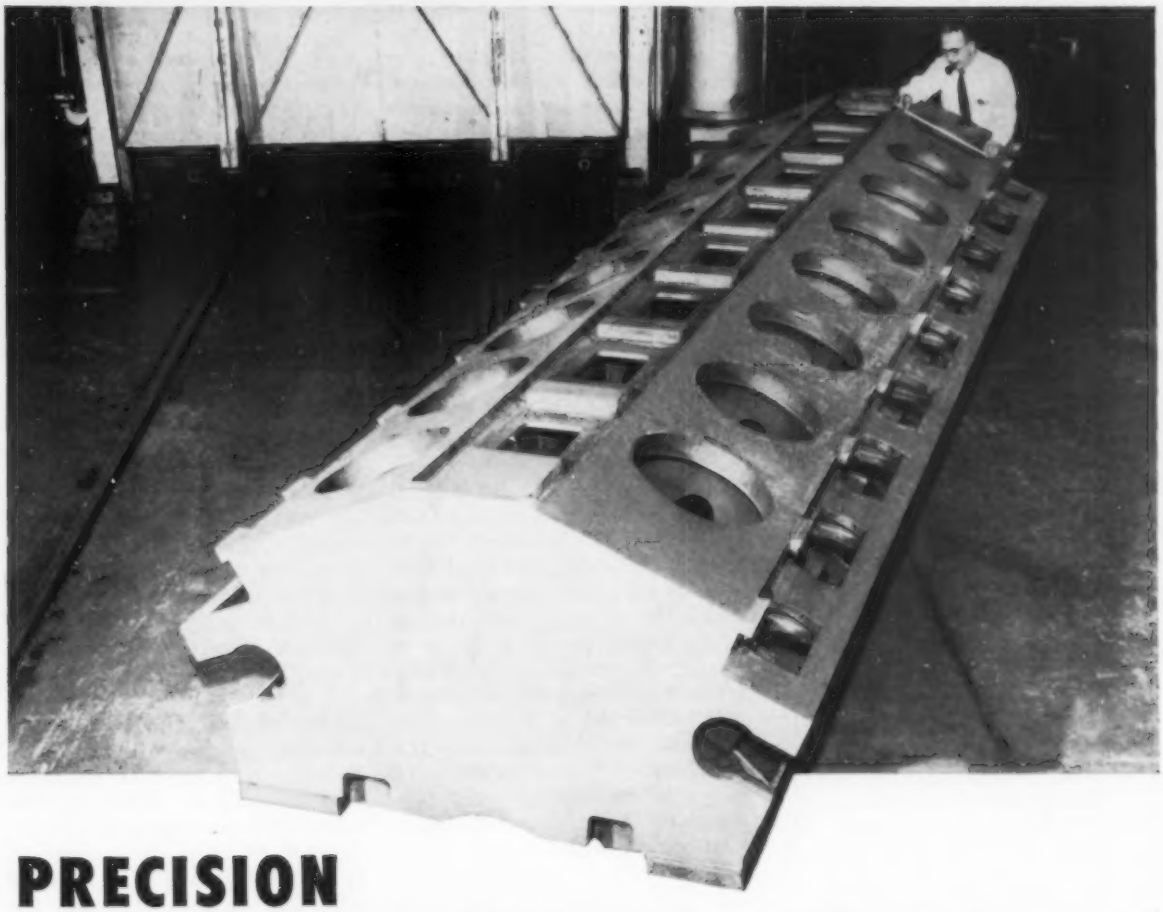

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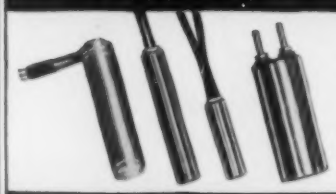

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When your hot problems call for unusual specifications, you get a speedy solution through *Vulcan Versatility* — in design, engineering and production. Standard or special, Vulcan is ready to supply your complete needs in low cost, efficient heating units. Send coupon for Catalog and prices.

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COMPANY.....
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The Hole Story

Holes, through all the centuries, have been a problem. Primitive man dug them only when he had to, because they represented a great deal of work, and in many soils, danger as well. Holes in his tools and clothing were likewise hard to make correctly and intentionally. The bow drill helped on small holes, but the demand for harder materials to be drilled continually eclipsed the margin of hardness between drill and drilled.

Thus our tradition tends to teach us to abhor a hole as something difficult and undesirable. "In the hole" became a figurative as well as a literal expression. We talked of "square pegs in round holes." We tended to dislike and distrust animals able to dig a hole and to live in it. We dug a hole by any means available, then fitted whatever was to go in it, whether the hole was in soil, wood or steel. We had difficulties in processing holes in metal, with straightness, circularity, parallelism, surface and size. Drills were traditionally the most costly, and the most heavily loaded, tools. Our instruments for measuring holes and their condition have traditionally been fewer and less accurate; OD has always been easier than ID.

But recently the concept is changing. We hear now that a production man doesn't buy a drill, but like the designer, he buys holes. We can make holes of a variety of shapes and sizes, to precise dimensions, and we have the tools to measure them. We've even learned, by electroforming, to build a part around the necessary holes, if there are enough of them to make it worthwhile.

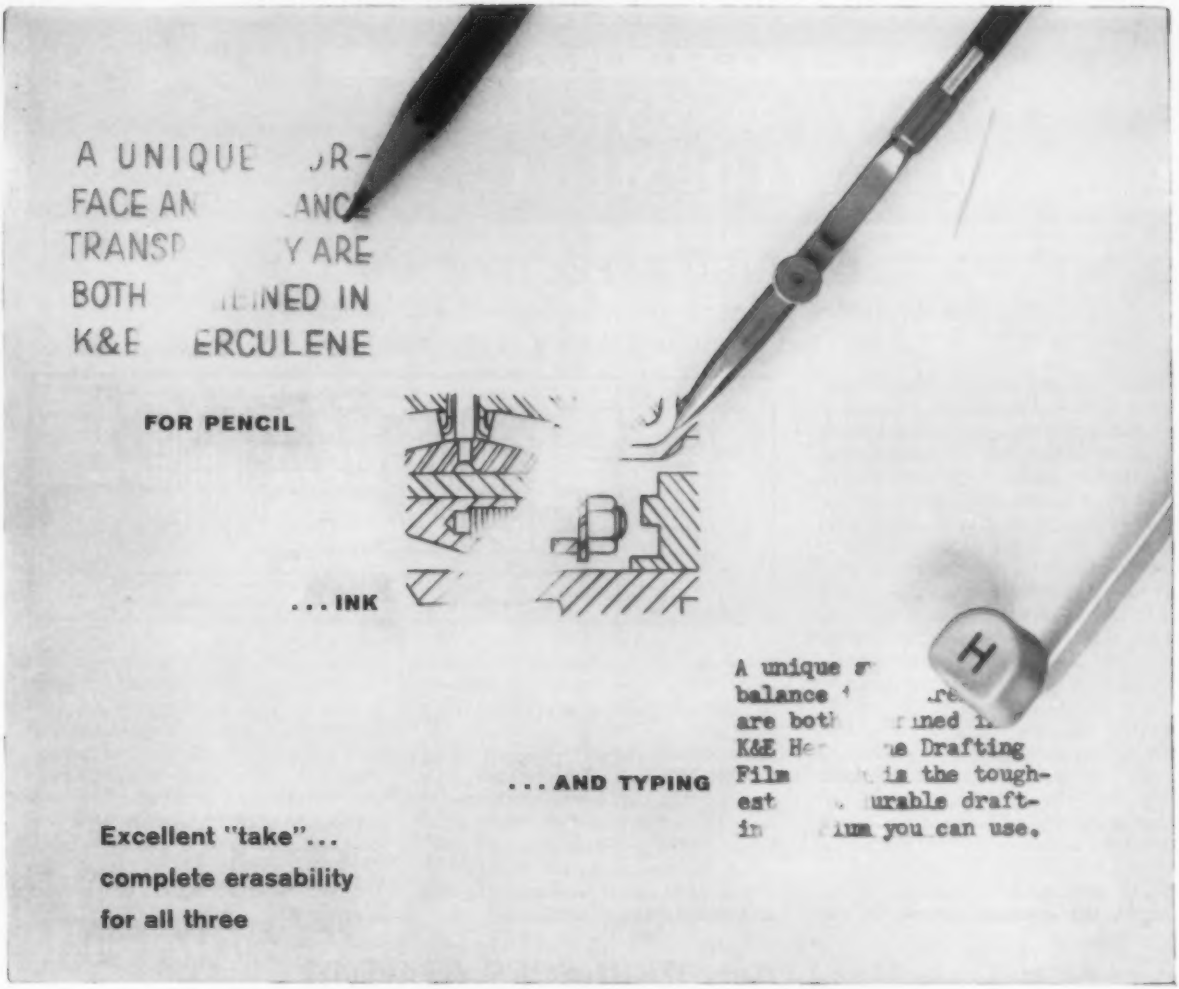
The scientist, too has seized upon the hole as an answer to many of his questions, and we have several theories built around the hole to explain otherwise inexplicable phenomena. There are electron "holes" in semiconductors (*PE*—Aug. 25, p. 10 and Sept. 15, p. 74). They're theoretical holes, but they explain what happens. Now come such men as J. S. Dahler of Wright Air Development Center to explain and predict molecular motions in liquids by saying it's all a matter of molecular "holes". These holes are postulated as actual voids in the crystalline lattice structure, and their number and distribution may be the key to the observed phenomena in liquids, which are much more complex than gases and solids. Molecules don't move around much in solids, and move so freely in gases that there's little chance of collision. But in a liquid . . . !

Anyway, these observations on holes are prompted by a paragraph in a letter Mr. Dahler wrote Anne Gardner, associate editor, when she sent him a checking copy of the story she was preparing on his theories that appeared in the Science section of our Sept. 8 R & D issue. (This is our standard practice when time permits; it's easier and better to be sure copy is correct in advance than it is to risk errors that will have to be excused later.)

Here's the paragraph, discussing the difference between holes in semiconductor materials:

". . . The holes introduced into the statistical description of liquids are actual voids in the fluid, i.e. regions that contain no molecules. In determining the thermodynamical behavior of the fluid, these holes function to lower the number of immediate neighbors to a particular molecule, thus lower the magnitude of the force upon the molecule and provide a somewhat larger space for it to occupy. In solids, a comparable situation is described as a "lattice vacancy" and should be clearly distinguished from "holes in solids". This is an unfortunate semantical situation. The term "holes in solids", i.e., in semiconductors, refers not to actual void spaces in the crystalline lattice but to holes or vacancies in the electronic energy bands. Thus, a hole in a semiconductor is an energy hole. These energy holes, immersed as they are in a "sea" of electrons, act as though they were positively charged bodies. In this way one arrives at the notion of moving electron holes, discusses the mobility of these holes, and the dynamical paths that they follow in moving through the solid. Viewed from this standpoint, the only similarity of holes in liquids and holes in

(Continued on page 145)



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NEWS FROM FLEXONICS

BELLOWS RESEARCH AND DEVELOPMENT

One of a series of reports on more effective use of metallic bellows in new or unusual applications.

MATCHED EFFECTIVE AREA

New Flexonics technique provides bellows with effective areas matched to within 2% on a production basis

One of the problems of pressure sensitive bellows actuated devices is compensation for changes in atmospheric pressure. Flexonics Corporation has solved this problem with assemblies of bellows of matched effective area.

As indicated in Figure 1, the twin bellows are opposed mounted in a frame. The motor bellows is connected to the fluid system in which pressure is to be measured or controlled. However, this bellows is also affected by changes in external or atmospheric pressure. The compensating bellows, being sealed and completely evacuated is affected solely by the same changes in atmospheric pressure.

By joining the bellows and mounting them in a restraining frame, changes in atmospheric pressure will cause the motion of the two bellows to oppose one another. In the case of reduced atmospheric pressure, for example, the extension caused in the motor bellows is offset by the extension of the compensating bellows thereby maintaining a constant control point.

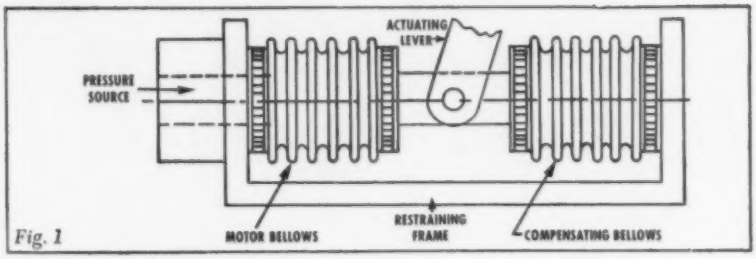

Fig. 1

Since force equals pressure times the effective area of the bellows, it is obvious that the secret of successful compensation is based on close matching of bellows effective areas. At Flexonics, effective areas are matched to within 2% in actual production. Spring rate is also closely controlled.

Such balanced performance is necessary for precision control of fuels, gases, air, pressure differentials, mixture of elements or ingredients and multiple recording devices under varying environmental conditions. Linkage may be achieved in a variety of ways to operate valves, rheostats, switches, dial indicators, needle jets or weights.

Further information is available on request. Send an outline of your requirements.

BELLOWS REPLACES CLUTCH

Unique application of Flexon Bellows in flow control valve serves to vary compressor load as demand changes

A bellows operated valve made by John E. Mitchell Co., Dallas, Texas, manufacturers of Mark IV automobile air conditioners, serves to replace a clutch that is required in other conditioners. The purpose of the clutch is to engage and disengage the compressor according to demand on the system and varying engine speed.

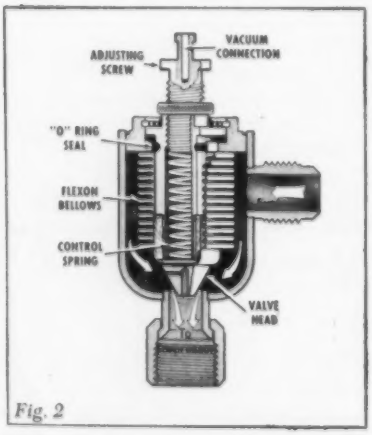

Fig. 2

Varying engine speed results in varying compressor speed and consequently in varying refrigeration effect. The Mitchell bellows-operated Robo-Trol valve compensates for the speed variations by controlling the rate of flow of refrigerant.

The interior of the bellows is connected to manifold vacuum. Thus the internal bellows pressure is higher at high speeds than at low speeds. Refrigerant at suction side pressure exerts force on the exterior of the bellows. The resultant pressure differential, directly related to engine (and compressor) speed governs the degree of opening of the valve.

Varying system demand is reflected in varying suction side pressure (the greater the demand, the higher the pressure) so the valve also adjusts flow in response to the requirements of the system.

Here is another good example of how Flexon Bellows can be used to do a control job more efficiently and more effectively. If your design requires pressure or thermostatic actuation or control investigate the advantages of Flexon Bellows or Bellows Assemblies. Just send an outline of your requirements.

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DESIGNER'S CHECK LIST

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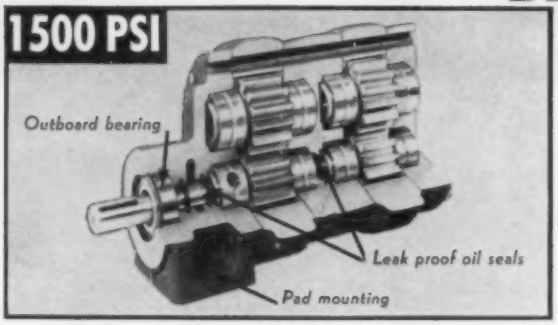
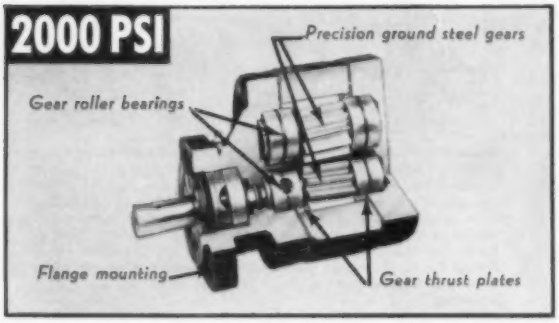


Two gear pumps assembled in tandem on common shaft deliver independently—can be piped for dual operation or combined for double capacity single operation. "Pressure Pocketing" reduces slippage, friction and wear—volumetric and mechanical efficiency over 90%.

2000 PSI

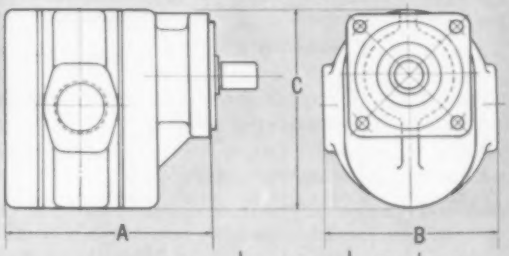


Single gear motor can be piped from side on end ports. Extra large gear bearings maintain shaft alignment; heavy-duty outboard bearing absorbs drive shaft and shock loadings. New leakproof oil seals maintain internal pressure balance.

PUMPS — — — DEVELOP OIL HYDRAULIC POWER
1500 PSI—2 to 100 gpm—continuous duty operation
2000 PSI—12 to 36 gpm—continuous duty operation

MOTORS — — UTILIZE OIL HYDRAULIC POWER
1500 PSI — 2 to 68 hp—continuous duty operation
2000 PSI —12 to 36 hp—continuous duty operation

DIMENSIONAL DATA (Approx.)



		A*	B	C
1500 PSI	C SERIES	4″ + gw	4″	4½″
	D SERIES	5¼″+ gw	6½″	6¾″
	J SERIES	7″ + gw	8″	9″
2000 PSI	36H SERIES	6½″+ gw	6½″	7⅛″

*When fitted with socket head cap screws. If fitted with hex head cap screws add thickness of head. gw = gear width

Actual performance data for pumps and motors having gear width other than one inch can be computed by multiplying values in following tables by desired gear width.

1500 PSI

	AVAILABLE GEAR WIDTHS	SPEED (RPM)	PUMPS OUTPUT PER INCH OF GEAR WIDTH (gpm at discharge pressure psi) 500	1000	1500	PUMPS INPUT PER INCH OF GEAR WIDTH (hp at discharge pressure psi) 500	1000	1500	SPEED (RPM)	MOTORS INPUT PER INCH OF GEAR WIDTH (gpm at input pressure psi) 600	1000	1500	MOTORS OUTPUT PER INCH OF GEAR WIDTH (hp at input pressure psi) 600	1000	1500
C SERIES	½″, 1″, 1½″	600	2.3	1.1	0.5	1.2	2.3	3.5	600	4.1	4.7	5.3	0.8	1.4	2.4
		1200	4.5	3.6	2.6	2.4	4.5	7.0	1000	7.1	7.4	7.7	1.3	2.4	3.4
		1800	7.2	6.0	5.5	3.8	6.7	10.5	1500	9.6	10.4	10.8	1.9	3.5	4.5
D SERIES	½″, ¾″, 1″, 1½″, 2″, 2½″, 3″	600	6.6	6.4	6.3	2.6	4.0	7.0	600	8.2	8.6	9.0	2.1	3.5	4.3
		1200	13.2	13.0	13.0	5.2	8.0	13.5	1000	12.5	13.6	14.0	3.5	5.8	8.0
		1800	19.3	19.0	19.0	7.5	12.0	20.5	1500	18.0	19.0	20.0	4.3	8.0	11.2
J SERIES	2″, 2½″, 3″, 3½″, 4″	600	9.7	9.3	9.2	3.1	6.1	9.0	600	10.6	10.9	11.6	2.8	5.1	7.7
		1200	20.6	20.3	20.0	6.4	12.3	18.7	1000	17.1	17.7	18.4	4.3	7.9	12.4
		1800	31.0	30.5	30.1	10.2	19.3	29.4	1500	27.0	27.5	28.7	5.1	10.7	17.1

2000 PSI

	AVAILABLE GEAR WIDTHS	SPEED (RPM)	PUMPS OUTPUT PER INCH OF GEAR WIDTH (gpm at discharge pressure psi) 1000	1500	2000	PUMPS INPUT PER INCH OF GEAR WIDTH (hp at discharge pressure psi) 1000	1500	2000	SPEED (RPM)	MOTORS INPUT PER INCH OF GEAR WIDTH (gpm at input pressure psi) 800	1200	2000	MOTORS OUTPUT PER INCH OF GEAR WIDTH (hp at input pressure psi) 800	1200	2000
36H SERIES	1″, 1½″, 2″, 2½″, 3″	600	4.7	4.5	3.9	4.7	7.4	8.8	600	6.9	7.3	8.0	2.3	3.7	6.2
		1200	12.3	12.1	11.7	9.5	14.2	19.8	1000	11.2	11.7	12.7	3.3	5.6	10.2
		1800	20.0	19.3	18.9	14.8	21.4	29.3	1600	*	18.9	20.1	*	6.8	14.2

* not recommended for 1″ or 2″ gears at 1600 rpm

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- Non-contaminating
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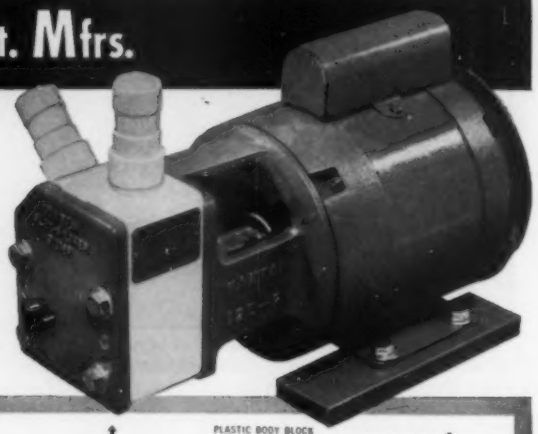
- Operates wet or dry



Designed to give complete protection against leakage, corrosion, and maintenance problems.

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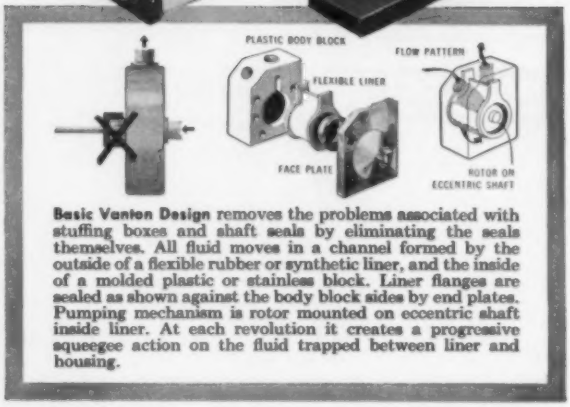
This new Vanton pump is designed to provide the equipment manufacturer with a low-cost, versatile, simple yet carefully engineered unit, problem-free with minimum maintenance. Construction materials at present available include PVC, high-temperature polyethylene, Teflon*, Buna N, bakelite, or stainless steel, in capacities from 1/3-10GPM. For information, write for BULLETIN CC10.1.

*Reg. trade mark of E. I. DuPont & Co.



Basic Vanton Design removes the problems associated with stuffing boxes and shaft seals by eliminating the seals themselves. All fluid moves in a channel formed by the outside of a flexible rubber or synthetic liner, and the inside of a molded plastic or stainless block. Liner flanges are sealed as shown against the body block sides by end plates. Pumping mechanism is rotor mounted on eccentric shaft inside liner. At each revolution it creates a progressive squeegee action on the fluid trapped between liner and housing.

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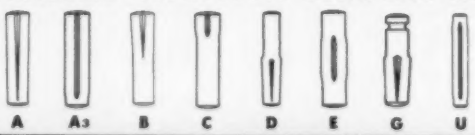

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solids is the word "hole", which is a singularly unfortunate choice. In liquids, the presence of holes is useful for it provides a simple picture of how a molecule moves from one part of the fluid to another: the molecule progresses from one point to another by "jumping" from hole to hole. The process of diffusion, therefore, is to be associated with the displacement of a molecule from one site in the quasi-lattice to a neighboring unoccupied site or hole, and so on."

Here is clear evidence that the hole has come to stay as an honored visitor —and also evidence that our language is fast becoming inadequate. Another proof is the number of new terms we publish in our glossaries on the Science and Materials pages. English has perhaps more versatility than any other language, yet we tend to reduce ourselves to a very limited vocabulary, and to fight against new words because they are not known or understood. Yet slang terms enter the language easily, understood or not (although in recent years these newly introduced terms are used so broadly that they soon lose picturesqueness—the only excuse for coining them in the first place). If we were to go to the basic metaphor of this discussion, there's a hole in our logic or in our education that is big enough to swallow our vocabularies.

There's one story about holes I cannot forebear telling here. It is perhaps the original shaggy-hole story, but it will serve to close our discussion. It concerns an Englishman of

(Continued on page 147)

"Me . . . I prefer to work on vellum."

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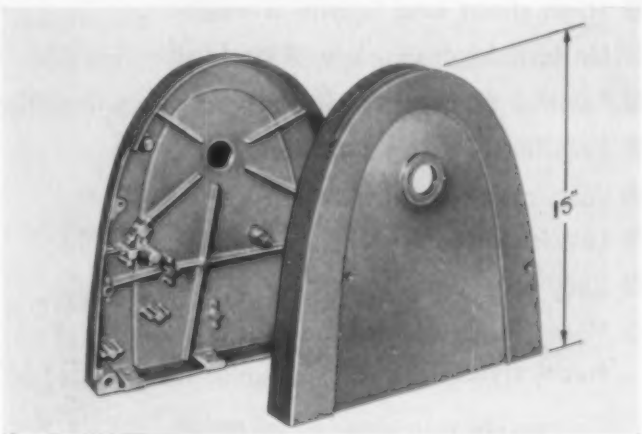

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Model	MV-137 SERIES, 3-way, N.O. or N.C. Magnetically Operated
Pressure	Inlet—0 to 4500 psi
Characteristics	Hermetically sealed
	Operating voltage—14 to 32 V. D. C.
	Ambient temp. range −100° F to + 250° F.
	Fluid Temp. range −65° F to + 250° F.
	Controls the flow through what is equivalent to a sharp edge orfice diameter—0.030

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some consequence who had the world's finest collection of holes of all shapes and sizes. (Don't laugh—archaeologists collect holes; they show where posts used to be.) There was, however, one gem of a hole on a neighboring estate. The collector envied the owner, was resolved to get possession of it.

Thus, when the owner of the hole ended his mortal days, the hole collector was almost happy, and rushed to the auction early to bid it in. All day he waited, while paintings, statuary, tapestries and objets d'art were knocked down. Finally, the hole was put on the block, and he got it for his first excited bid of five guineas.

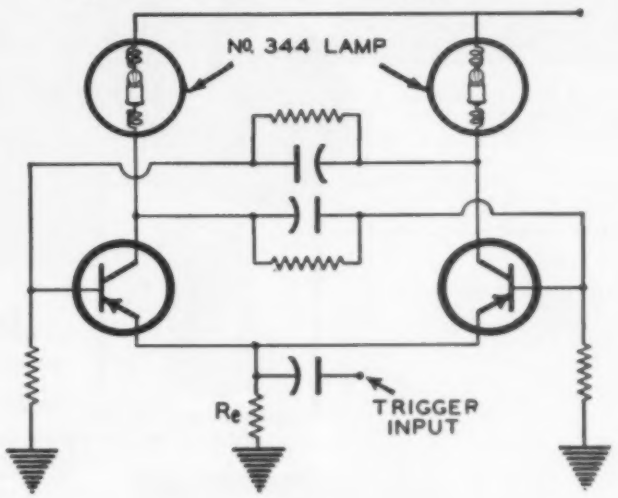
The next problem was how to get his new possession home. He finally rang up his son and asked him to rent the largest lorry available. With some difficulty, the two loaded the hole on the lorry and started home. All went well until they were well down the lane leading to their home. The son suddenly remarked: "The lorry drives differently somehow, father. Might we have lost the hole?"

They stopped for an examination, and the son's worst fears were realized. The hole had somehow joggled off. The lane was a typical narrow one of rural England, with hedges close on either side and no turnoff for some distance ahead. Besides, twilight was rapidly becoming night. So they couldn't turn around, and they couldn't leave the hole as a hazard. They decided to back up to it. Unfortunately, they couldn't see well in the dark, so they backed into the hole, and neither they nor the lorry have been seen since. —EJT

"I was rubbing it like this when oops, *here he comes again!"*

General Electric announces new "VERY LOW CURRENT" lamp for use as indicators for transistorized circuits

A possible use: as an indicator on a flip-flop circuit.



GE-344 incandescent lamp is rated at 10 volts, 15 milliamperes; has life in excess of 5,000 hours

Twice actual size

General Electric's new GE-344 is designed for use in transistor circuits and many other applications where a small sized, low current indicator lamp is needed. Only 7/32" in diameter, 5/8" long, the GE-344 can be seen lighted under 100 footcandles of surrounding light. It uses only .15 watts (nominal), has a single contact midget flange base, and its electrical ratings allow significant savings in providing an indicator light in transistorized equipment. For additional engineering data on this new GE-344 lamp, write: General Electric Co., Miniature Lamp Dept. PE-98, Nela Park, Cleveland 12, Ohio. Ask for Bulletin No. 3-8066.

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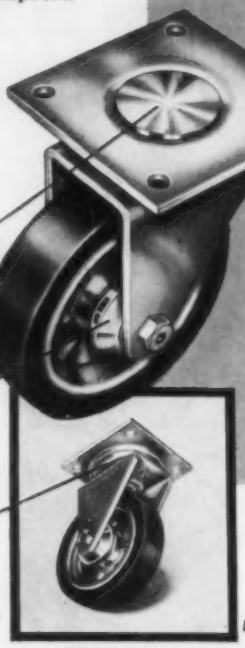
Dust and moisture shield protects cup-and-cone wheel bearing assembly from hot water, steam, lint dust, sawdust, threads, etc.

Intermediate raceway is also designed to provide a combination dust guard and moisture shield to protect the lubrication.



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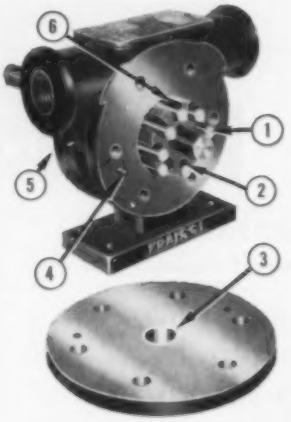

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Check these design features:

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3) Interchangeable needle and journal bearings provide proper load carrying capacity for application.
4) Cap screw closure with dowel pin alignment insures easy access to pump interior.
5) Adjustable stuffing box, in rear of housing, with return seal and soft packing keeps shaft wear and chance of leakage to a minimum.
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DESIGN ABSTRACTS

Form and Position Tolerances

These types of tolerances are critical where interchangeability is important and established practices are inadequate. A system for defining such factors as flatness, straightness, angularity, perpendicularity, parallelism, concentricity, true position and a method of noting them on engineering drawings is given.

This is the first of two articles on the subject. Previous article in this series, in the June 16 issue of the same publication, was entitled, "Geometric and Positional Tolerancing."

"True-position Tolerancing," W. H. Harrington, Avco Mfg Corp; American Machinist, Aug 11, '58, 330 W 42nd St, New York 36.

Silicate Esters as Functional and Lubricating Fluids

A new series of condensed silicate esters is based on the familiar ethyl silicate 40, used in preparation of molds for precision casting. Viscosity-temperature relationships, flash points, pour points, hydrolytic stabilities and other pertinent data are given.

"Silicate Esters as Functional Fluids and Synthetic Lubricants," P. H. Miller, L. Pierce, Jr., G. M. Goodale, Union Carbide Chemicals Co, Div of Union Carbide Corp; presented at Sept 7-12 meeting of Div of Chemical Marketing and Economics, American Chemical Society, 1155 16th St, NW, Washington 6, D. C.

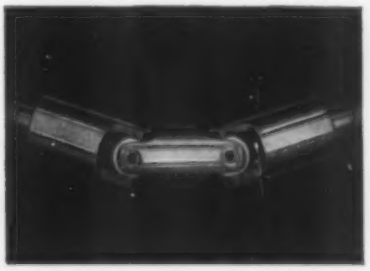
The Complexity Barrier

The intricate mechanical, hydraulic, pneumatic, electrical and electronic systems required in present-day aeronautic equipment imposes a need for analysis while development and design are still underway, instead of waiting for the testing of expensive, complex prototypes. Some of the procedures required for "debugging" designs, components and systems as they are developed are discussed. These include: failure-effect analysis, reliability and availability, obtaining and evaluating test data, failure histories, monthly statistical reviews.

"To Beat the Complexity Barrier," I. de S. Coutinho, Grumman Aircraft Engineering Corp; Mechanical Engineering, Aug '58, 29 W 39th St, New York 18.

How Curtis helped a design engineer "BEAT THE HEAT"

This single universal joint in a ribbon-stripping machine was operated at a 34° angle. The joint heated up, wear was excessive. (Curtis Joints have been tested at angles up to 37°, but we do not ordinarily recommend angles greater than 30°.)



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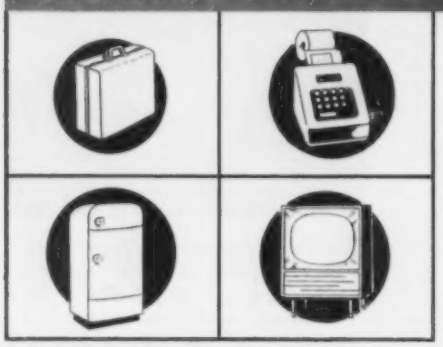

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NEW BOOKS

NOMA Glossary of Automation Terms

National Office Management Assn., Willow-Grove, Pa. 8½x11, 35 pp., mimeographed, $2.

From "AC" (here defined as "a suffix meaning 'automatic computer' as in ORDVAC") to "ZONE" (a portion of internal storage allocated for a particular function or purpose . . .), this mimeographed 32-page glossary sticks tight to its field, defines many familiar words in the lingo of the computer engineer. The definitions are pedestrian and academic, but most are basically correct; however, in a few cases at least, trade marks are used without distinction.

Concise International Dictionary of Mechanics and Geology

S. A. COOPER, ***400 pp., 4½x7½, Philosophical Library, Inc., 15 E. 40 St., New York 16, $6.***

Prepared for the traveling engineer and scientist by a British linguist, this plump little volume should prove just as useful at home. It contains French, German, and Spanish equivalents of "the expresssions most commonly used" (about 5,000 of them) in mathematics, mineralogy, metallurgy, mechanics, and electrical engineering. It's easy to read, too, and equivalents are easy to find.

Management and Organization

LOUIS A. ALLEN. ***Published by McGraw-Hill Book Co., 330 W. 42nd St, New York 36. 6x9, 353 pp. $7.***

This is a book that should help management men (1) make the organization changes necessary to expand profits; (2) analyze their organizations for faster, sounder growth; and (3) advance their personal careers in professional management. The book is based in part on analysis of 168 companies—a 3-year study recently completed for the National Industrial Conference Board.

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Nonlinear Magnetics & Magnetic Amplifiers

Published by AIEE, 29 W 30th St, New York 36. 482 pp, 8½x11, $7.

Proceedings of the Special Technical Conference on this subject sponsored by the AIEE, IRE and ISA in Los Angeles, Aug 6-8, include some papers that may prove of interest to the design engineer concerned with control system problems. Here are titles of such papers: "Recommended Symbols for Magnetic Amplifier Papers," "Application of Magnetic Amplifiers to Electronic Timers," "High-frequency, Temperature-stable Magnetic Amplifiers," "Ferroresonant Switching Circuits."

Engineering Economy

CLARENCE E. BULLINGER. *Published by McGraw-Hill Book Co., 330 W. 42nd St., New York 36. 6¼x9¼, 370 pp. $7.*

An engineering decision, in most instances, is not simply an answer to the question, "What are the technical solutions to this problem?" A technical analysis can only be evaluated when accompanied by an economic analysis. More and more, engineers are being asked the additional question, "What will it cost?"

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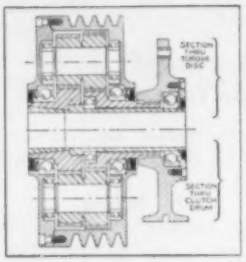

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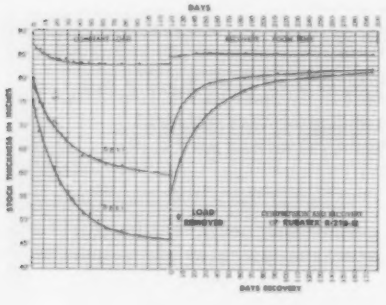

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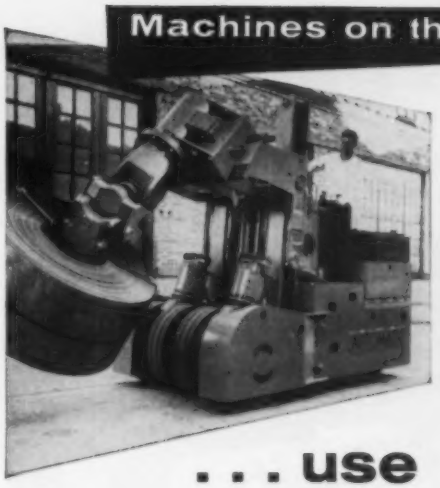

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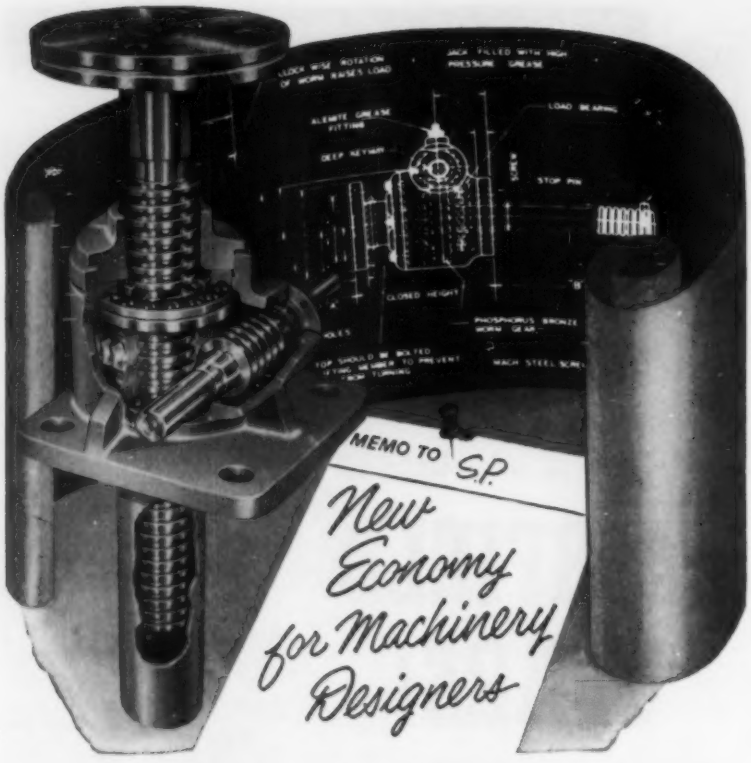

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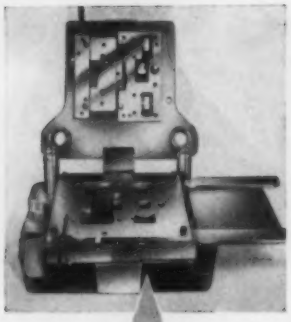

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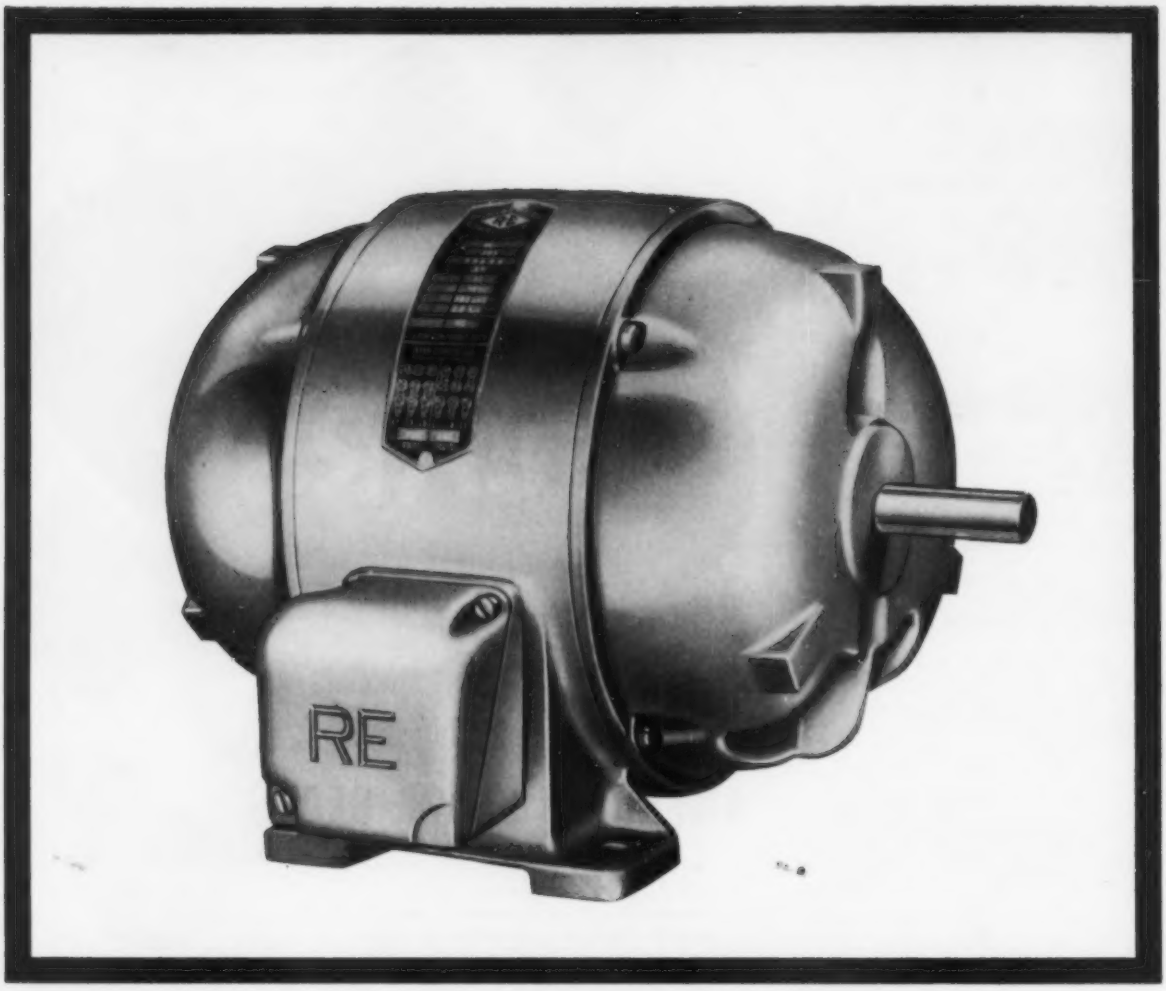

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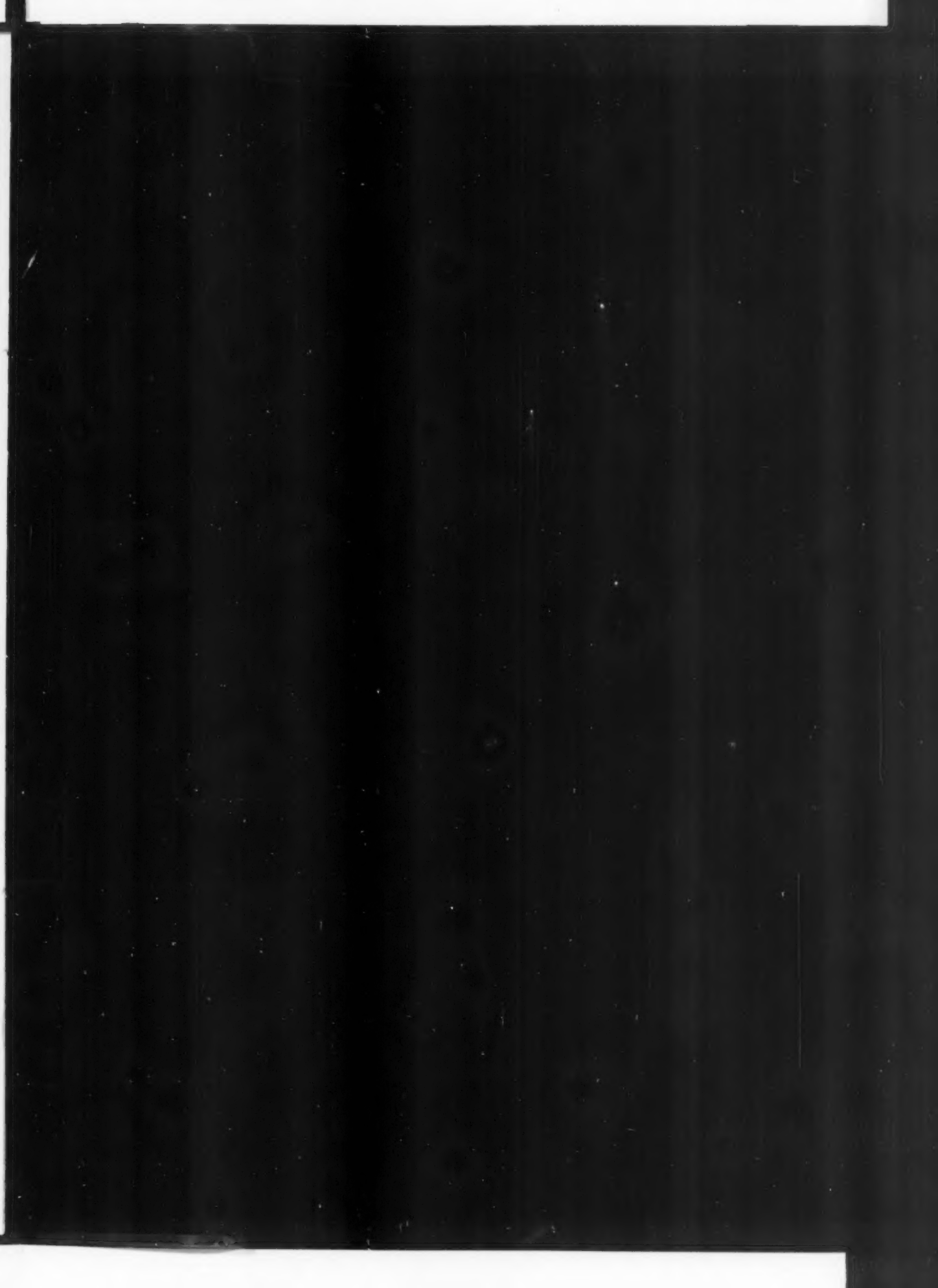

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9—Miniature Universal Joint
7—Variable Speed Pulley
20—DC Motor Brakes
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5—Gas Turbine Power Package
8—Intermittent-duty Motor
11—Multiple-function Counters
10—Hydraulic Motors
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1	13	25	37	49	61	73	85	97	109	121	133	145	157	169	181	193	205	217	229	241	253	265	277
2	14	26	38	50	62	74	86	98	110	122	134	146	158	170	182	194	206	218	230	242	254	266	278
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5	17	29	41	53	65	77	89	101	113	125	137	149	161	173	185	197	209	221	233	245	257	269	281
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9	21	33	45	57	69	81	93	105	117	129	141	153	165	177	189	201	213	225	237	249	261	273	285
10	22	34	46	58	70	82	94	106	118	130	142	154	166	178	190	202	214	226	238	250	262	274	286
11	23	35	47	59	71	83	95	107	119	131	143	155	167	179	191	203	215	227	239	251	263	275	287
12	24	36	48	60	72	84	96	108	120	132	144	156	168	180	192	204	216	228	240	252	264	276	288

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19—Electronic Delay Relay

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4—Split-flapper Check Valve
2—Synthetic Felt Seal
13—Heavy-duty Separator
15—Hydraulic Pumps
17—High-pressure Switch
21—Three-way Servo Valve
23—Hydraulic Shutoff Valve
24—In-line Control Valve
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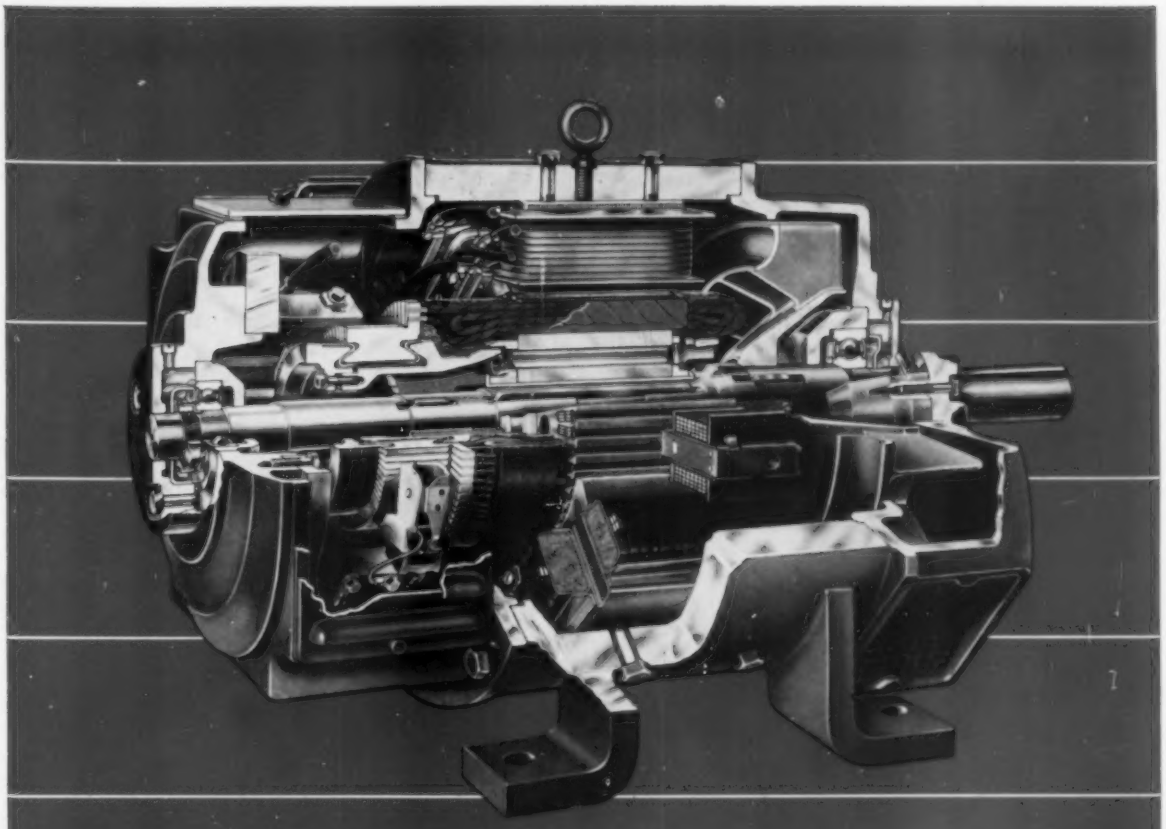

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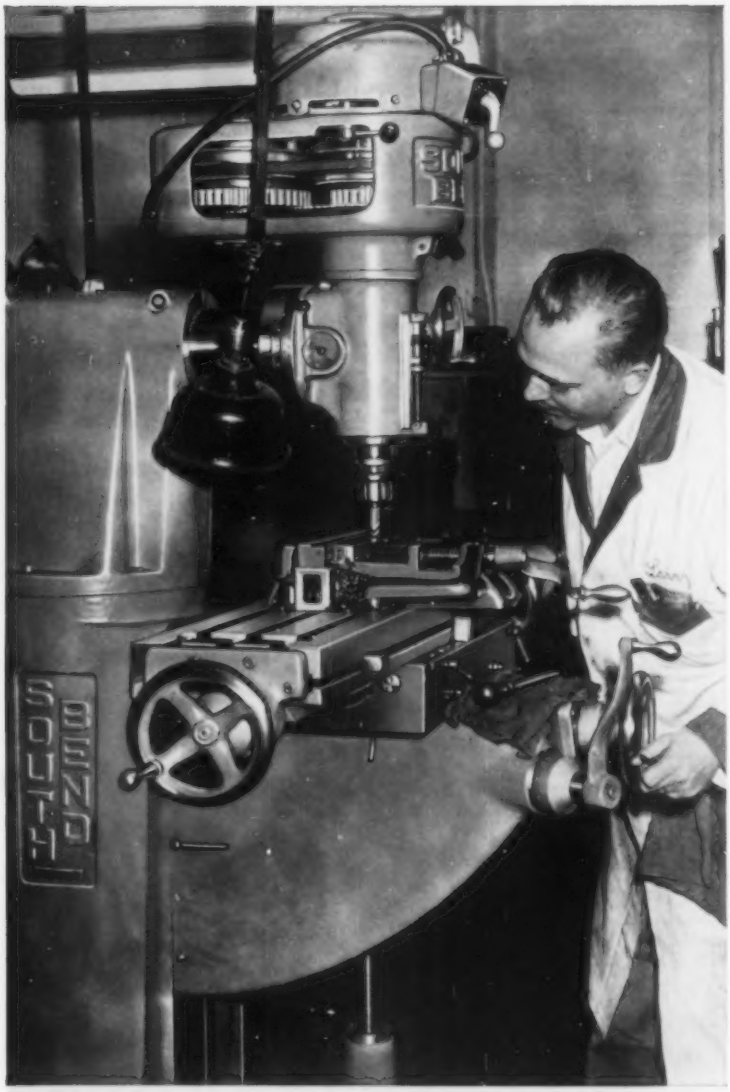

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